ACOLS'2005

7th Australasian Conference on Optics, Lasers and Spectroscopy

incorporating

* the 18th Australian Optical Society Conference
* the 10th Australian Laser Conference
* the 20th Australian Spectroscopy Conference

5 – 9 December 2005

Royal Lakeside Novotel
Rotorua, New Zealand

Conference proceedings

The ACOLS'2005 conference at a glance

Monday

7:00pm–9:00pm	**Welcome reception**	

Tuesday

8:45am–10:30am	**TuJ** ■ Joint session, D. Wineland and G. Modugno	
10:30am–11:00am	**Morning tea**	
11:00am–12:30pm	**TuA** ■ Spectroscopy 1	**TuB** ■ Quantum Optics 1
12:30pm–2:00pm	**Lunch break**	
2:00pm–3:30pm	**TuC** ■ Cold Atoms & BEC 1	**TuD** ■ Optical Fibres 1
3:30pm–4:00pm	**Afternoon tea**	
4:00pm–5:45pm	**TuE** ■ Biophotonics	**TuF** ■ Imaging & Instrumentation
6:00pm–8:00pm	**TuP** ■ Poster session	

Wednesday

9:00am–10:30am	**WeJ** ■ Joint session, A. I. Ferguson and B. Culshaw	
10:30am–11:00am	**Morning tea**	
11:00am–12:45pm	**WeA** ■ Lasers 1	**WeB** ■ Optical Fibres 2
	Free afternoon	

Thursday

9:00am–10:30am	**ThJ** ■ Joint session, S. N. Houde-Walter and J. Jones (on behalf of J. Ye)	
10:30am–11:00am	**Morning tea**	
11:00am–12:30pm	**ThA** ■ Spectroscopy 2	**ThB** ■ Cold Atoms & BEC 2
12:30pm–2:00pm	**Lunch break**	
2:00pm–3:45pm	**ThC** ■ Lasers 2	**ThD** ■ Quantum Optics 2
3:45pm–4:00pm	**Afternoon tea**	
4:00pm–5:30pm	**ThP** ■ Poster session	
6:30pm	**Conference dinner (Rutherford room)**	

Friday

9:00am–10:30am	**FrJ** ■ Joint session, R. Blatt and A. O. Caldeira	
10:30am–11:00am	**Morning tea**	
11:00am–12:15pm	**FrA** ■ Cold Atoms & BEC 3	**FrB** ■ Quantum Optics 3
	Conference conclusion	

Monday

Registration (6:00pm–7:00pm, foyer area)

Welcome reception (7:00pm–9:00pm)

Tuesday

Registration (open from 8:00am, foyer area)

Batten 1 & 2 room

8:45am–10:30am
TuJ ■ Joint session
Pr. Howard Carmichael, The University of Auckland, Presider

8:45am **Introductory remarks**

9:00am TuJ1 — **Quantum-mechanically entangled atoms and raising Schrödinger's cat** **Invited**

D. Wineland. National Institute of Standards and Technology, Boulder (Colorado), USA
Quantum state control of trapped ions enables the demonstration of the elements of quantum information processing (QIP). A useful quantum computer is probably far in the future, but simple forms of QIP can help in metrology, as in atomic clocks.

9:45am TuJ2 — **Experiments with Fermi-Bose mixtures** **Invited**

G. Modugno. University of Florence, Sesto Fiorentino, Italy
I will report on experiments with ultracold Fermi-Bose mixtures of potassium and rubidium atoms, involving periodic potentials and control of the interactions via magnetic Feshbach resonances.

Morning tea (10:30am–11:00am)

Batten 1 room

11:00am-12:30pm
TuA ■ Spectroscopy 1
Dr. Ken Baldwin, The Australian National University, Presider

11:00am

TuA1 — Optics, lasers and spectroscopy: Resonance at work

Keynote

B. J. Orr. Macquarie University, Sydney (NSW), Australia

Resonances in molecules, optical cavities, sensitive instruments and beyond enable a range of innovative experimental research on spectroscopic sensing, on high-performance sources of tunable coherent light, and on fundamental studies of molecular processes.

11:30am

TuA2 — Luminescence of Eu ions in epitaxial fluoride superlattices

R. J. Reeves[a], S. Gastev[b], J. K. Choi[a], K. R. Hoffman[c], A. V. Krupin[b], and N. S. Sokolov[b]. [a] University of Canterbury, Christchurch, New Zealand. [b] Ioffe Physico-Technical Institute of RAS, St. Petersburg, Russia. [c] Whitman College, Walla Walla (WA), USA

Laser excitation and emission spectroscopy of europium reveals novel interface centers in superlattices of insulating fluoride films. The temperature dependence of emission gives the binding energy of electrons in the potential wells of the superlattices.

11:45am

TuA3 — Spectral encoding of semiconductor nanocrystals embedded in polymer matrix

J. W. M. Chon, C. Bullen, J. Moser, and M. Gu. Swinburne University of Technology, Hawthorn (Victoria), Australia

In this paper, we discuss the spectral encoding capability of semiconductor nanocrystals (NCs) and its application to high-density optical data storage. The effect of polymer matrix and energy transfer between the NCs are also studied.

12:00pm

TuA4 — Spectrally distinguishable metal nanorods for 3-D data storage

C. Bullen, J. W. M. Chon, and M. Gu. Swinburne University of Technology, Hawthorn (Victoria), Australia

We discuss spectral encoding using metal nanorods which possess polarization- and aspect ratio- dependent optical properties. The incorporation of chemical prepared nanorods into composites for application to high density optical data storage is described.

Batten 2 room

11:00am-12:30pm
TuB ■ Quantum Optics 1
Pr. Howard Wiseman, Griffith University, Presider

11:00am

TuB1 — Fighting it out over quantum state tomography

Keynote

A. C. Doherty, A. Gilchrist, and M. deBurgh. University of Queensland, St Lucia (QLD), Australia

I will describe an efficient method for reconstructing quantum states from data that can be interpreted as a contest between the eager experimentalists and a sceptical theorist aiming to question the consistency of the data set.

11:30am

TuB2 — One-way quantum computation with a multi-photon cluster state

P. Walther[a], K. J. Resch[a], T. Rudolph[b], E. Schenck[a], H. Weinfurter[c,d], V. Vedral[a,e,f], M. Aspelmeyer[a], and A. Zeilinger[a,g]. [a] University of Vienna, Wien, Austria. [b] Imperial College London, London, UK. [c] Ludwig Maximilians University, Munich, Germany. [d] Max Planck Institute for Quantum Optics, Garching, Germany. [e] The Erwin Schrödinger Institute for Mathematical Physics, Vienna, Austria. [f] University of Leeds, Leeds, UK. [g] Austrian Academy of Sciences, Vienna, Austria

The one-way model based on cluster states is a new method for quantum computation. We have demonstrated the production of photonic cluster states and used them to perform quantum logic from single-qubit operations to a 2-qubit realization of Grover's algorithm.

11:45am

TuB3 — Demonstrating superior discrimination of locally prepared states using nonlocal measurements

J. L. O'Brien[a], G. J. Pryde[a], S. D. Bartlett[b], and A. G. White[a]. [a] University of Queensland, Brisbane (QLD), Australia. [b] University of Sydney (NSW), Australia

Two-qubit entangling gates allow realizations of new generalized quantum measurements. We use photons to demonstrate entangling measurements realizing superior discrimination of locally-prepared two-qubit states relative to what is achievable with local measurements and classical communication.

12:00pm

TuB4 — Hyperentangled photons

J. T. Barreiro[b], N. K. Langford[a], N. A. Peters[b], and P. G. Kwiat[b]. [a] University of Queensland (QLD), Australia. [b] University of Illinois at Urbana-Champaign, Urbana (IL), USA

Many quantum information protocols require higher dimensional entanglement. Using photons entangled independently in spatial modes, polarization, and energy, we realize a source of "hyperentanglement" and demonstrate nonlocal correlations in every degree of freedom.

12:15pm

TuA5 — High-speed infrared spectrometer for respiratory diagnostics

I. Shvarchuck[a,b] and G. Murray[b]. [a] Fisher & Paykel Healthcare, Auckland, New Zealand. [b] The University of Auckland, Auckland, New Zealand

We present the details of a high-speed infrared spectrometer developed for clinical research applications in respiratory humidification. Various aspects of wavelength-modulation spectroscopy are discussed.

TuB5 — Super-resolving phase measurements via time reversal

K. J. Resch, K. L. Pregnell, R. Prevedel, A. Gilchrist, G. J. Pryde, J. L. O'Brien, and A. G. White. University of Queensland, Brisbane (QLD), Australia

Quantum metrology promises super-precise measurement. Common wisdom holds it is necessary to produce entanglement. We exploit time-reversal to show the simpler task of measuring entanglement suffices: our 6-photon experiment yielding the highest phase super-resolution ever demonstrated.

Lunch break (12:30pm–2:00pm)

Batten 1 room

2:00pm-3:30pm
TuC ■ Cold Atoms & BEC 1
Dr. Maarten Hoogerland, The University of Auckland, Presider

2:00pm

TuC1 — The development of the atom laser **Keynote**

J. D. Close, N. P. Robins, C. Figl, M. Jeppesen, S. A. Haine, M. Johnsson, and J. J. Hope. The Australian National University, Canberra (ACT), Australia

This talk will be an introduction to atom lasers, an analysis of the present state of the field and a discussion of future applications of atom lasers to precision measurement.

2:30pm

TuC2 — Scattering of ultracold atoms using a collider

A. Mellish[a], N. Kjaergaard[a], P. Julienne[b], and A. C. Wilson[a]. [a] University of Otago, Dunedin, New Zealand. [b] National Institute of Standards and Technology, Gaitherburg (MD), USA

We report cold-collision measurements made using a magnetic collider for ultracold atoms. From images of partial-wave interference we determine the differential cross-sections associated with collisions involving atoms in single and mixed hyperfine states of ^{87}Rb.

2:45pm

TuC3 — Atom lasers from elongated quasi-condensates

C. J. Vale[a], O. Vainio[b], M. J. Davis[a], N. R. Heckenberg[a], and H. Rubinsztein-Dunlop[a]. [a] University of Queensland, St Lucia (QLD), Australia. [b] University of Turku, Turku, Finland

Phase fluctuations are characteristic of Bose-Einstein condensates in lower dimensions. We use atom laser output from condensates and quasi-condensates to probe their axial phase coherence properties.

Batten 2 room

2:00pm-3:30pm
TuD ■ Optical Fibres 1
Dr. Stéphane Coen, The University of Auckland, Presider

TuD1 — Parametric processing of classical and quantal signals **Keynote**

C. J. McKinstrie[a] and S. Radic[b]. [a] Bell Laboratories, Lucent Technologies, Holmdel (NJ), USA. [b] University of California at San Diego, La Jolla (CA), USA

Parametric amplifiers based on four-wave mixing in fibers enable signal amplification and idler generation (with gain), and signal-to-idler frequency conversion (without gain). Recent research on parametric signal processing will be reviewed, and the implica-tions of this research for classical and quantal communication sys-tems will be discussed.

TuD2 — Nonlinear dynamics of polarization modulation instability in birefringent optical fiber

S. Iyer, S. G. Murdoch, R. Leonhardt, and J. D. Harvey. The University of Auckland, Auckland, New Zealand

The nonlinear dynamics of polarization modulation instability in the depleted pump regime is investigated. Oscillations in the sidebands' power as a function of input-pump power are observed. These dynamics have a possible application as a nonlinear optical switch.

TuD3 — Tunable cross-phase modulation instability in photonic crystal fibres

G. K. L. Wong[a], J. S. Y. Chen[a], R. J. Kruhlak[a], S. G. Murdoch[a], R. Leonhardt[a], J. D. Harvey[a], and N. Y. Joly[b]. [a] The University of Auckland, Auckland, New Zealand. [b] University of Bath, Claverton Down, Bath, United Kingdom

Continuously tunable cross-phase modulation instability in photonic crystal fibres was demonstrated experimentally in the normal dispersion regime. The experimental results are in good agreement with the theoretical analysis.

3:00pm

TuC4 — BEC on a permanent magnetic film atom chip

B. Hall, S. Whitlock, F. Scharnberg, P. Hannaford, and A. Sidorov. Swinburne University of Technology, Hawthorn (Victoria), Australia

We present an atom chip that uses permanent magnetic film to create ^{87}Rb Bose-Einstein condensates. We have used these condensates as a sensitive probe of the magnetic field produced above the film edge.

TuD4 — Observation of the elliptically polarized fundamental vector soliton of isotropic Kerr media

M. Delqué and T. Sylvestre. University of Franche-Comté, Besançon, France

We report the first experimental observation of the elliptically polarized fundamental vector soliton of isotropic Kerr media and its unique polarization evolution. This was achieved in the spatial domain in a CS_2 Kerr planar waveguide.

3:15pm

TuC5 — Bragg spectroscopy of ultra-cold fermions

K. J. Challis, R. J. Ballagh, and C. W. Gardiner. University of Otago, Dunedin, New Zealand

We present a theoretical treatment of Bragg scattering of ultra-cold fermions. The Bragg spectra contain a broad first order Bragg resonance and a narrow resonance arising from Bragg enhancement of the gap function.

TuD5 — Ultrafast optical oscillator locked by Kerr feedback

P. Kockaert, G. Kozyreff, C. Cambournac, T. Erneux, and M. Haelterman. Université libre de Bruxelles, Bruxelles, Belgium

We show, analytically and numerically, that a double-pass ring cavity with dispersion and Kerr feedback presents modulational instability. Stable modes, at frequencies independent of the input power, suggest to use the system as a robust ultrafast optical oscillator.

Afternoon tea (3:30pm–4:00pm)

Batten 1 room

4:00pm-5:45pm
TuE ■ Biophotonics
Pr. Halina Rubinsztein-Dunlop, University of Queensland, Presider

Batten 2 room

4:00pm-5:45pm
TuF ■ Imaging & Instrumentation
Pr. Howard Carmichael, The University of Auckland, Presider

4:00pm

TuE1 — Optical coherence tomography: From fundamentals to clinical medical imaging

Keynote

D. D. Sampson, S. G. Adie, S. A. Alexandrov, J. J. Armstrong, T. R. Hillman, and M. S. Leigh. University of Western Australia, Perth, Australia

Optical coherence tomography is a medical imaging modality that is in clinical use but remains imperfectly understood and has great unrealised potential. We shall explore fundamental issues set by biological tissue and coherent image formation, as well as describe its evolution into a clinical imaging modality.

TuF1 — Sparse-aperture stellar interferometry: Striking gold in the optical antiques cabinet

Keynote

P. Tuthill. Sydney University (NSW), Australia

Sparse-aperture Fizeau interferometry presently sets the standard in recovery of high-fidelity images of celestial targets from ground-based telescopes. The technique, results, and future prospects for high resolution astronomical imaging are discussed.

4:30pm

TuE2 — Stable and robust polymer nanotubes stretched from polymersomes

J. E. Reiner, J. M. Wells, R. B. Kishore, C. Pfefferkorn, and K. Helmerson. National Institute of Standards and Technology, Gaithersburg (MD), USA

We create polymer nanotubes by pulling on the membrane of a polymer vesicles with optical tweezers followed by cross-linking to make them stable indefinitely. We also demonstrate the formation of vesicle-nanotube networks using this technique.

TuF2 — A differential Hartmann wave-front sensor

T.-L. Kelly and P. J. Veitch. University of Adelaide, Adelaide (SA), Australia

An optical testing system that combines multiple Hartmann-type measurements and novel data analysis is described. Optical characteristics can be determined accurately and precisely without detailed knowledge of the geometry of the measurement system or wavefront.

4:45pm

TuE3 — Single molecule detection in optically trapped nanocontainers

J. E. Reiner[a], A. M. Crawford[a], R. B. Kishore[a], L. S. Goldner[a], M. K. Gilson[b], and K. Helmerson[a].
[a] National Institute of Standards and Technology, Gaithersburg (MD), USA. [b] Center for Advanced Research in Biotechnology, Rockville (MD), USA

We demonstrate the creation and manipulation of microscopic containers suitable for performing small volume chemical reactions and single molecule spectroscopy. The containers are sub-micron diameter water droplets, which can be trapped by optical tweezers.

TuF3 — Superprism effects in 3D photonic crystals

J. Serbin and M. Gu. Swinburne University of Technology, Hawthorn (Victoria), Australia

We present experimental results on superprism phenomena inside polymer woodpile structures. The crystals fabricated by means of two-photon polymerization have a bandgap at 1.2ìm and show strongly frequency dependent dispersion at wavelengths slightly below their band gap.

5:00pm

TuE4 — High resolution single-scale investigation of a 3-dimensional butterfly photonic crystal

S. Wickham, M. Large, and L. Poladian. The University of Sydney (NSW), Australia

This paper presents a high-accuracy method for investigating the angle-dependent and spectral reflection properties of small domains (75 $\times$ 200 micron) of a 3-D photonic crystal found in several species of butterfly, using a supercontinuum source.

TuF4 — Polymer fibre Bragg gratings inscribed with a 355nm solid-state laser source

B. Ashton[a], M. Stevenson[a], C. Martelli[a], J. Canning[a], G. D. Peng[b], H. J. Kalinowski[c], and M. S. Milcsewski[c].
[a] University of Sydney, Eveleigh (NSW), Australia.
[b] The University of New South Wales, Sydney, Australia.
[c] Centro Federal de Educacao Tenologica do Parana, Curitiba, Brazil

Diode-pumped solid-state lasers offer a distinct advantage over traditional ion gas lasers, particularly in terms of beam stability, power consumption and coherence length. Here we have inscribed strong fibre Bragg gratings into polymer fibre with a 355nm solid state laser.

5:15pm

TuE5 — Illumination and effective fluorescence collection volumes for fibre optic probes in tissue

D. C. S. Tai, C. Soeller, D. A. Hooks, J. D. Harvey, and B. H. Smaill. The University of Auckland, Auckland, New Zealand

Illumination and fluorescence collection volumes of different optical fibres in tissue were characterized using 2-photon techniques. A 3D illumination model was also developed and validated. This study provides important information for optical probe design in biomedical applications.

TuF5 — Statistics of single electron signals in electron multiplying charge-coupled devices

T. Plakhotnik, A. Chennu, and A. V. Zvyagin. University of Queensland (QLD), Australia

Electron-multiplying CCD promises to revolutionise ultra-sensitive optical imaging. We present a simple methodology allowing reliable measurement of camera characteristics and report testing camera in a truly photon-counting regime eliminating the excess-noise related to fluctuations of the multiplication gain.

5:30pm

TuE6 — The role of an oil droplet lens in vision enhancement

L. P. Fischer, M. Vorobyev, T. Plakhotnik, and A. V. Zvyagin. University of Queensland (QLD), Australia

Light absorbed by some vertebrate cone photoreceptors is preconditioned by an oil droplet. The prevalence of transparent oil droplets indicates a dioptric function. Numerical modelling strongly suggests both chromatic and resolution enhancement.

TuF6 — Ellipsometry with polarisation-entangled photons

D. Graham, A. S. Parkins, and L. Watkins. The University of Auckland, Auckland, New Zealand

Ellipsometry using polarisation-entangled photon pairs by reconstruction of components of the density matrix is demonstrated. Results for external and total internal reflection in glass samples are presented.

Rutherford room

6:00pm–8:00pm
TuP ■ Poster session

TuP1 — Unexpected magneto-optical resonances in coherent atomic media

A. Akulshin, A. Sidorov, R. McLean, and P. Hannaford. Swinburne University of Technology, Hawthorn (Victoria), Australia

We have observed strong and unexpected subnatural width resonances of enhanced absorption in Rb vapour under particular experimental conditions. The resonances are polarisation dependent and appear to require a long atom-light interaction time.

TuP2 — Photon echoes produced via controlled inhomogeneous broadening

A. L. Alexander, J. J. Longdell, and M. J. Sellars. The Australian National University, Canberra (ACT), Australia

We demonstrate photon echoes in Eu^{3+}:Y_2SiO_5 by controlling the inhomogeneous broadening through the application of an external electric field gradient. This is the first demonstration of a key part of the photon echo based quantum memory scheme.

TuP3 — A phase-space tomographic technique to measure the coherence properties of scattered light

C. K. Aruldoss, N. Dragomir, R. E. Scholten, K. A. Nugent, and A. Roberts. The University of Melbourne, Melbourne (VIC), Australia

We demonstrate the application of a non-interferometric phase space tomographic technique to the reconstruction of spatial correlation functions of quasi-monochromatic optical wavefields after propagation through a scattering medium.

TuP4 — Nanofabrication with a metastable atomic beam

M. Baker, A. J. Palmer, and R. T. Sang. Griffith University, Nathan (QLD), Australia

We present here details of optical masking techniques applied to a Ne* metastable atomic beam source for atom lithography. Results will be presented of our initial attempts focusing Ne* atoms in optical standing waves to create nanometer size structures on thiolate resist covered substrates.

TuP5 — Quantum measurements and quantum Brownian motion

S. M. Barnett[a] and J. D. Cresser[b]. [a] University of Strathclyde, Glasgow, UK. [b] Macquarie University (NSW), Australia

The Markov approximation applied to quantum Brownian motion gives rise to unexpected problems, such as negative probabilities. Treating collisions as joint position-momentum measurements yields a simple Markovian description free of such difficulties.

TuP6 — Interconvertibility of single-rail optical qubits

D. W. Berry[a], A. I. Lvovsky[b], and B. C. Sanders[b,c]. [a] The University of Queensland (QLD), Australia. [b] University of Calgary, Alberta, Canada. [c] Macquarie University, Sydney (NSW), Australia

We show how to convert between single-rail optical qubits using linear optics and postselection. We introduce a generalised quantum efficiency for such states and show that any conversion that decreases this quantity is possible.

TuP7 — Raman spectroscopy of Mott insulator states in optical lattices

P. B. Blakie. University of Otago, Dunedin, New Zealand

We discuss a Raman spectroscopy technique for probing strongly-correlated systems in optical lattices. We show that spectral shifts can be used to reveal the filling-factor distribution of the system.

TuP8 — Bright tripartite entanglement in triply concurrent parametric oscillation

A. S. Bradley[a], M. K. Olsen[a], O. Pfister[b], and R. C. Pooser[b]. [a] University of Queensland, Brisbane (QLD), Australia. [b] University of Virginia, Charlottesville (Virginia), USA

A novel optical device utilising triply concurrent $\chi^{(2)}$ nonlinearities is shown to produce bright output beams with macroscopic intensities, and to exhibit strong tripartite entanglement above threshold. EPR correlations and extracavity fluctuation spectra are presented.

TuP9 — Quantum control of a single qubit

A. M. Branczyk[a], A. Gilchrist[a], S. D. Bartlett[b], and A. C. Doherty[a]. [a] The University of Queensland (QLD), Australia. [b] The University of Sydney, Sydney (NSW), Australia

We present a theoretical proposal to demonstrate quantum control of a single qubit, using weak measurements and feedforward of measurement results. We propose a prototype experiment to demonstrate this scheme with polarisation encoded photonic qubits.

TuP10 — Atom detection and counting in ultra-cold gases using photoionisation

T. Campey[a], D. Turk[a], C. J. Vale[a], M. J. Davis[a], J. Courteaud[b], N. R. Heckenberg[a], and H. Rubinsztein-Dunlop[a]. [a] The University of Queensland, St Lucia (QLD), Australia. [b] ENS Cachan, Cachan, France

Precision atom counting is essential in quantum atom-optics. We analyse two schemes involving photoionisation and ion detection, one for single atom detection and one for counting large atom numbers with accuracy better than $N^{-1/2}$.

TuP11 — New continuous-variables multipartite Bell-type inequalities

E. G. Cavalcanti and P. D. Drummond. The University of Queensland, Brisbane (QLD), Australia

We derive new multipartite Bell-type inequalities applicable to unbounded operators. In continuous variable systems the only measurements required are moments of quadrature operators. They could lead to a loophole-free test of local realism.

TuP12 — Optimum entanglement in mixed states of two qubits

S. Chan and Z. Ficek. University of Queensland, Brisbane (QLD), Australia

We study the maximum (optimized) entanglement that could ever be achieved in a mixed state of two atoms (qubits) undergoing irreversible decoherence, irrespective of the choice of initial conditions, excitations and observation time.

TuP13 — Rapid quantum state-purification using quantum feedback control

J. Combes[a] and K. Jacobs[a,b]. [a] Griffith University, Australia. [b] Louisiana State University

Consider using Hamiltonian feedback to increase the speed at which a continuous measurement purifies a quantum state. We establish a feedback algorithm which speeds up the purification by $2(N+1)/3$ for an observable with N equispaced eigenvalues.

TuP14 — Loading a novel magnetic trap with He*

R. G. Dall and A. G. Truscott. The Australian National University, Canberra (ACT), Australia

The ultimate aim of our research is to create a He* Bose Einstein condensate. To this end we have built a novel experimental apparatus to load atoms into a planar QUIC magnetic trap.

TuP15 — Two-mode theory of BEC interferometry

B. J. Dalton. Swinburne University of Technology, Melbourne (Victoria), Australia

A two-mode theory of BEC interferometry for small boson numbers in asymmetrical double-well traps has been developed, leading to self-consistent sets of equations for the amplitudes of fragmented states and for the two single boson mode functions.

TuP16 — Experimental quantum control with linear optics

R. B. Dalton, G. Gillett, K. J. Resch, G. J. Pryde, J. L. O'Brien, A. M. Branczyk, and A. G. White. University of Queensland, Brisbane (QLD), Australia

Controlling quantum systems is difficult because measurement affects quantum systems. Quantum control is possible using weak measurements, which trade off disturbance vs. information. We discuss progress on the first experimental demonstration of an optimal protocol for quantum control.

TuP17 — Exact results for one-dimensional disordered bosons with strong repulsion

A. De Martino[a], M. Thorwart[a], R. Egger[a], and R. Graham[b]. [a] Heinrich-Heine-Universitaet, Duesseldorf, Germany. [b] Universitaet Duisburg-Essen, Essen, Germany

We study strongly repelling ultracold bosons in a one-dimensional configuration with a random potential created, e.g., by a laser-speckle field. We show that disorder destroys the usual bosonic quasi-long-range order by calculating the momentum distribution. Furthermore results from the theory of Anderson localization of fermions are used to obtain results for the distribution function of the local density of states, the spectral statistics, and density-density correlations.

TuP18 — Phase-space analysis of the quantum phase transition in the Dicke model

F. Dimer de Oliveira, A. S. Parkins, and H. J. Carmichael. The University of Auckland, Auckland, New Zealand

A phase-space analysis of the quantum phase transition in the Dicke Hamiltonian is presented for the thermodynamic limit. Linearization within the Haken representation is compared with a phase-space implementation within the Holstein-Primakov representation.

TuP20 — Molecular BEC via the association of ultracold Fermionic atoms

G. Duffy, J. Fuchs, G. Veeravalli, P. Dyke, B. J. Dalton, P. Hannaford, and W. Rowlands. Swinburne University of Technology, Hawthorn (Victoria), Australia

We aim to produce a Bose-Einstein condensate of ultra-cold lithium molecules via the association of ultra-cold fermionic 6Li atoms. We will report progress of our work towards the production of a MBEC.

TuP21 — Ultra-high frequency squeezing in an optical parametric oscillator

A. E. Dunlop[a], E. H. Huntington[a], C. C. Harb[b], and T. C. Ralph[c]. [a] The University of New South Wales, Canberra (ACT), Australia. [b] The Australian National University, Canberra (ACT), Australia. [c] The University of Queensland, St Lucia (QLD), Australia

Because multimode operation of an optical parametric oscillator emits a comb of correlated photon pairs, we predict squeezing at multiple cavity resonances. Effects of noise, seeding and detuning on ultra-high frequency squeezing are investigated.

TuP22 — Quantum random walk of a harmonically trapped atom in a standing-wave field

R. Fisher, L. Horvath, M. Collett, and H. J. Carmichael. The University of Auckland, Auckland, New Zealand

The quantum random walk of a harmonically trapped atom in a standing-wave field undergoing spontaneous emission is analyzed. Localization of the oscillation amplitude of the atom in the trap can occur due to a nonadiabatic time averaging of its coupling to the field.

TuP23 — The Kosterlitz-Thouless transition in 2D Bose gases

C. J. Foster[a], P. B. Blakie[b], and M. J. Davis[a]. [a] The University of Queensland, Brisbane (QLD), Australia. [b] University of Otago, Dunedin, New Zealand

The 2D Bose gas undergoes a topological phase transition to the Kosterlitz-Thouless superfluid state. We study the dynamics and pairing of vortices in this system using the classical field approximation.

TuP24 — Focus anomaly of a Laguerre-Gaussian beam

X. Gan, B. Jia, and M. Gu. Swinburne University of Technology, Hawthorn (Victoria), Australia

An asymmetric rotation of the focal field is detected in the focal region of a Laguerre-Gaussian beam, focused by a high NA objective lens through an index mismatched interface satisfying the total internal reflection condition.

TuP25 — Non-Markovian decay of cascade atoms in structured reservoirs

B. M. Garraway[a] and B. J. Dalton[b]. [a] University of Sussex, Brighton, UK. [b] Swinburne University of Technology, Melbourne (Victoria), Australia

The non-Markovian dynamics of a three-level cascade atom coupled to structured reservoirs associated with high Q cavities or photonic band gaps is treated using coupled amplitude equations or master equations involving fictitious harmonic oscillator modes (pseudomodes).

TuP26 — A class of 2D permanent magnetic lattices for ultracold atoms and BECs

S. Ghanbari, T. D. Kieu, B. J. Dalton, A. Sidorov, and P. Hannaford. Swinburne University of Technology, Melbourne (Victoria), Australia

We report on a class of permanent magnetic lattices for producing 2D arrays of magnetic microtraps with non-zero potential minima and variable barrier height for trapping and manipulating ultracold atoms and Bose Einstein condensates.

TuP27 — Entanglement cycles and conditional quantum evolution in an open cavity system

M. Gu, A. S. Parkins, and H. J. Carmichael. The University of Auckland, Auckland, New Zealand

We consider a open cascaded quantum system where measurements made within the environment lead to a previously un-observed phenomenon of Quantum Cycles; stochastic trajectories that oscillate between two perfectly entangled Bell States.

TuP28 — Dissociation spectra as probes of Feshbach resonances

T. M. Hanna and T. Köhler. University of Oxford, Oxford, United Kingdom

We describe recent numerical results concerning association and dissociation of Feshbach molecules. In particuler, we show that very fast magnetic field ramps may be used to deduce properties of Feshbach resonances.

TuP29 — Dynamics of the nitrogen-vacancy colour centre in diamond

J. Harrison, M. J. Sellars, and N. B. Manson. The Australian National University, Canberra (ACT), Australia

The presentation gives an account of the optical excitation dynamics of the nitrogen-vacancy centre in diamond as relates to its use as a single photon source and its use in quantum information processing.

TuP30 — Loss-tolerant parity codes for linear optics quantum computing

A. Hayes, A. Gilchrist, and T. C. Ralph. University of Queensland (QLD), Australia

We present a photon-loss tolerant encoding for linear optics quantum computing based on parity states. The parity states can be created and manipulated with an efficiency competitive with that of cluster state schemes.

TuP31 — Iterative phase retrieval of Fresnel diffraction data: Characterization of focussed beams

C. Henderson, H. Quiney, and K. Nugent. The University of Melbourne (VIC), Australia

Intense coherent X-ray sources under development will allow obtaining diffraction data from nano-scale non-crystalline objects. We have developed an iterative algorithm which will retrieve the phase of such objects and which characterizes focussed beams.

TuP32 — Diffraction-contrast imaging of cold atoms in excited and coherent states

C. S. Hofmann and R. E. Scholten. University of Melbourne (VIC), Australia

We have demonstrated off-resonant imaging of a cold atom cloud by extracting the atomic column density from a diffraction pattern, without lenses or other imaging elements. We are now applying the technique to imaging of non-ground-state atoms.

TuP33 — Self-trapping in the dynamical tunneling of Bose-Einstein condensates

S. Holt, M. J. Davis, C. J. Vale, and H. Rubinsztein-Dunlop. The University of Queensland, Brisbane (QLD), Australia

We study the effect of atomic interactions in the dynamical tunneling of Bose-Einstein condensates. We find an excellent analogy with the tunneling regimes of the well-studied two-mode model, and consider experimental implementations.

TuP34 — A dipole trap for quantum information applications

M. D. Hoogerland. The University of Auckland, Auckland, New Zealand

We trap ultracold ^{87}Rb atoms in a dipole trap formed by the focus of a CO_2 laser. We will present current results on evaporative cooling to increase the phase space density.

TuP35 — Multi-mode character of superradiant emission from 3D extended sources

L. Horvath[a], J. P. Clemens[b], B. C. Sanders[c,d], and H. J. Carmichael[a]. [a] The University of Auckland, Auckland, New Zealand. [b] Miami University, Oxford (Ohio), United States. [c] Macquarie University (NSW), Australia. [d] University of Calgary, Alberta, Canada

The multi-mode character of superradiance from 3D extended sources is explored using a quantum trajectory unravelling of the superradiance master equation and a bosonic approximation for the collective atomic modes. Limitations of previous single-mode treatments are discussed.

TuP36 — Stabilising an atom laser using spatially selective pumping and feedback

M. Johnsson, S. A. Haine, and J. J. Hope. The Australian National University, Canberra (ACT), Australia

We present detailed numerical simulations of a pumped atom laser using Gross-Pitaevski equations, including spatially dependent pumping and a feedback stabilisation scheme. The feedback scheme drastically reduces laser fluctuations.

TuP37 — Ensemble quantum information processing: Demonstrating nonlocality

S. J. Jones, H. M. Wiseman, and D. T. Pope. Griffith University, Australia

We re-examine the constraints inherent to ensemble QIP and arrive at a stronger constraint for NMR ensembles than previously considered. We then construct a Bell inequality for this system and demonstrate when this inequality is violated.

TuP38 — An exploration of the travelling salesman problem with quantum adiabatic processes

T. D. Kieu. Swinburne University of Technology, Melbourne (VIC), Australia

We employ an algorithm for the travelling salesman problem based on the quantum adiabatic processes which incorporate quantum tunnelling and the quantum adiabatic theorem. Analytical investigations and numerical simulations of the algorithm will be presented.

TuP39 — Rotating tweezers and fast particle tracking for characterization of biopolymer fluids

G. Knöner[a], M. Caggioni[b], S. Parkin[a], N. R. Heckenberg[a], D. A. Weitz[b], and H. Rubinsztein-Dunlop[a]. [a] University of Queensland, Brisbane (QLD), Australia. [b] Harvard University, Cambridge (MA) ,USA

We apply rotating tweezers and fast particle tracking microrheology to solutions of hyaluronic acid (HA). We quantify local inhomogeneities close to the employed probe particles and measure the viscoelastic properties of the HA entanglement network.

TuP40 — Enhanced quantum reflection of matter-wave solitons

C. Lee. The Australian National University, Canberra (ACT), Australia

Matter-wave bright solitons, which are usually looked as macroscopic objects with classical particle-like behaviors, are found to reflect from a purely attractive potential with a pronounced switching from reflection to transmission.

TuP41 — A scheme of quantum memory based on Fabry-Perot etalon

P. M. Leung and T. C. Ralph. University of Queensland, Brisbane (QLD), Australia

A 2-mirrors Fabry-Perot etalon with adjustable mirrors separation can transmit narrow frequency photons and reflect others. The feasibility of using two Fabry-Perot etalons as a quantum memory device for quantum computing is investigated.

TuP42 — Computational modelling of optically-driven microrotors

V. L. Y. Loke, T. A. Nieminen, N. R. Heckenberg, and H. Rubinsztein-Dunlop. The University of Queensland (QLD), Australia

We use a hybrid FDFD-T-matrix method to calculate optical forces and torques exerted on a microrotor in optical tweezers.

TuP43 — Hyperfine characterisation of Eu:Y_2SiO_5

J. J. Longdell, A. L. Alexander, and M. J. Sellars. The Australian National University, Canberra (ACT), Australia

We present a detailed characterisation of the hyperfine structure of Eu dopped in Y_2SiO_5. Such a characterising should lead to much longer coherence times, with possible applications in quantum computing and quantum networks.

TuP44 — Combining continuous variable entanglement distillation and purification

A. P. Lund[a], W. P. Bowen[b], and T. C. Ralph[a]. [a] The University of Queensland, St Lucia (QLD), Australia. [b] University of Otago, Dunedin, New Zealand

We combine a continuous variable entanglement distillation scheme with a purification scheme to study the possible entanglement generated by this combination.

TuP45 — Multi-quantum eigenstates of a linear chain of qubits

C. Mewton and Z. Ficek. University of Queensland, Brisbane (QLD), Australia

We present a technique to identify exact analytic expressions for the multi-quantum eigenstates of a linear chain of coupled qubits without imposing periodic boundary conditions. The treatment is valid for an arbitrary number of atoms and any size of the chain.

TuP46 — Optically-driven micromachines and microtools

T. A. Nieminen, J. Higuet, G. Knöner, V. L. Y. Loke, S. Parkin, W. Singer, N. R. Heckenberg, and H. Rubinsztein-Dunlop. The University of Queensland, Brisbane (QLD), Australia

We review the physics and methodology of the application of optical forces and torques, and the implications for the design and manufacture of optical micromachines.

TuP47 — Continuous variable quantum teleportation of resonance fluorescence

C. Noh and H. J. Carmichael. The University of Auckland, Auckland, New Zealand

We derive analytic expressions for the spectrum and intensity correlation function of the broadband field recovered by Bob in continuous variable quantum teleportation of resonance fluorescence. The expressions are comapred with results from quantum trajectory simulations.

TuP48 — Bipartite spatial entanglement from coupled parametric waveguides

M. Olsen[a], P. D. Drummond[a], and N. Olivier[b]. [a] University of Queensland, Brisbane (QLD), Australia. [b] École Nationale Supérieure des Techniques Avancées, Paris, France

We show that evanescently coupled optical parametric oscillators are a source of output beams which exhibit entanglement and Einstein-Podolsky-Rosen correlations. We analyse the system in both the above and below threshold regimes.

TuP49 — Quantifying orbital angular momentum transfer in optical tweezers

S. Parkin, T. A. Nieminen, N. R. Heckenberg, and H. Rubinsztein-Dunlop. The University of Queensland (QLD), Australia

Orbital angular momentum transfer to particles trapped by optical tweezers allows controlled rotation with a comparatively large torque. We present a method to measure this torque which allows for quantitative measurements of microscopic systems.

TuP50 — Tapered fibre lenses for the manipulation of particles

A. Ratnapala, G. Knöner, T. A. Nieminen, C. J. Vale, N. R. Heckenberg, and H. Rubinsztein-Dunlop. The University of Queensland, Brisbane (QLD), Australia

We have experimentally shown that tapered fibre lenses can create tight atom traps. We have also mapped out the trapping force they apply to polystyrene beads in water.

TuP51 — Mode-matching effects in linear optics quantum computing

P. P. Rohde and T. C. Ralph. University of Queensland, Brisbane (QLD), Australia

One of the greatest challenges facing the development of linear optics quantum computing is mode-mismatch. We construct a simple error model for mode-mismatch and examine its effects in the cluster state model for quantum computation.

TuP52 — Femtosecond Z-scan studies of cubic nonlinear optical properties of salmon DNA

M. Samoc[a], A. Samoc[a], A. Miniewicz[a], and J. G. Grote[b]. [a] The Australian National University, Canberra (ACT), Australia. [b] Air Force Research Laboratory, Wright-Patterson Air Force Base, OH, USA

DNA derived from salmon roe is emerging as an unusual material possessing attractive properties for photonic applications. We investigated dispersion of cubic nonlinear optical properties of this material using a tunable high-power femtosecond laser system.

TuP53 — Variational approach to vortex-antivortex excitation pairs in two-dimensional condensates

D. Schumayer and D. A. W. Hutchinson. University of Otago, Dunedin, New Zealand

Vortex-antivortex excitation pair in two-dimensional condensate is treated here using variational calculation minimizing the free energy. We determine how the temperature and total particle number affect the distance between the vortices.

TuP54 — Manipulation and growth of protein crystals using optical tweezers

W. Singer[a], U. J. Gibson[b], T. A. Nieminen[a], N. R. Heckenberg[a], and H. Rubinsztein-Dunlop[a]. [a] University of Queensland, Brisbane (QLD), Australia. [b] Dartmouth College, Hanover, Germany

Optical tweezers can be used to manipulate and grow protein crystals allowing crystal modification studies while changing the growing conditions. We demonstrate the abilities of this method and propose future applications.

TuP55 — Complementarity of resources: Extractable work, accessible entanglement and reference frame ability

J. A. Vaccaro[a,b], F. Anselmi[b], H. M. Wiseman[a], and K. Jacobs[a]. [a] Griffith University, Nathan (QLD), Australia. [b] University of Hertfordshire, Hatfield, UK

Superselection rules limit the resources represented by quantum states. We find a triality between the extractable work, accessible entanglement, and reference frame ability for a bipartite system in a globally-symmetric pure state.

TuP56 — Homodyne measurement of average photon number

J. G. Webb[a], T. C. Ralph[b], and E. H. Huntington[a]. [a] The University of New South Wales, Canberra (ACT), Australia. [b] The University of Queensland, St Lucia (QLD), Australia

Homodyne measurement of mean photon number within an optical sideband is performed and discussed. Comparison with single photon detector data illustrates the versatility of the technique and supports a Quantum Mechanical description of vacuum noise.

TuP57 — Multi-qubit circuits with a simplified entangling gate

T. J. Weinhold[a,b], G. J. Pryde[a,b], J. L. O'Brien[a,b], K. J. Resch[a], and A. G. White[a,b]. [a] University of Queensland, Brisbane (QLD), Australia. [b] Center for Quantum Computer Technology, Brisbane (QLD), Australia

We present the optical experimental implementation of a novel two-qubit entangling gate, free of classical interferometers. We fully characterize and utilize it to generate multi-qubit states suitable for quantum computing and tests of quantum mechanics.

TuP58 — Atom-surface effects in a stable magnetic environment

S. Whitlock, B. Hall, P. Hannaford, and A. Sidorov. Swinburne University of Technology, Hawthorn (Victoria), Australia

We investigate mechanisms of heating and loss for trapped ultra-cold atoms close to the surface of a permanent magnetic film. The magnetic potential is strongly fragmented and is used to produce multiple separated condensates.

TuP59 — A high flux cold atom source for atom chips

H. Wolff, T. Mapperson, B. Hall, and A. Sidorov. Swinburne University of Technology, Hawthorn (Victoria), Australia

We report on the design, construction and characterisation of a high flux, low velocity source of ultra-cold rubidium atoms for the rapid loading of a permanent magnetic film atom chip apparatus.

TuP60 — Numerical study of the stability of Skyrmions in Bose-Einstein condensates

S. Wüster, T. E. Argue, and C. M. Savage. The Australian National University, Canberra (ACT), Australia

We show that the stability of three-dimensional Skyrmions in trapped Bose-Einstein condensates (BECs) depends critically on various parameters of the setup. We numerically find Skyrmions with as low as 2×10^6 atoms, to facilitate their experimental creation.

TuP61 — Imaging and sizing of diamond nanoparticles

A. V. Zvyagin, Y. Colpin, A. Swan, and T. Plakhotnik. The University of Queensland, St. Lucia (QLD), Australia

A method of sizing individual dielectric nanoparticles makes use of dramatic size-dependence of the optical scattering cross-section in the Rayleigh limit. We report sub-video-frame-rate imaging and sizing of diamond nanocrystals, which represent potentially attractive optical labels.

Wednesday

Registration (open from 8:00am, foyer area)

Batten 1 & 2 room

9:00am–10:30am
WeJ ■ Joint session
Pr. John Harvey, The University of Auckland, Presider

9:00am WeJ1 — **Nonlinear optical microscopy** **Invited**

A. I. Ferguson. University of Strathclyde, Glasgow, Scotland, UK

Some of the progress that has taken place in nonlinear microscopy over the past decade will be reviewed, concentrating on the developments in novel light sources for microscopy and advanced multiphoton microscopy techniques. Progress will be illustrated using examples from the life sciences.

9:45am WeJ2 — **Gas spectroscopy in the near infrared: Optical fibre networks for safety and environmental monitoring** **Invited**

A. Cheung[a], B. Culshaw[a], K. Duffin[a], W. Johnstone[a], A. McGettrick[a], I. Mauchline[b], and D. Moodie[b]. [a] University of Strathclyde, Glasgow, UK. [b] OptoSci Limited, Glasgow, UK

Tuneable diode laser spectroscopy via optical fibres has demonstrated reliable, accurate measurements on landfill. Laboratory assessments of pressure broadening promise to further enhance prospects especially for applications in environmental monitoring, process control and aerospace.

Morning tea (10:30am–11:00am)

Batten 1 room

11:00am-12:45pm
WeA ■ Lasers 1
Pr. Norman Heckenberg, University of Queensland, Presider

11:00am WeA1 — **Recent developments of laser applications in microfabrication and microdiagnostics** **Keynote**

J. A. Piper. Macquarie University, Sydney (NSW), Australia

Studies of ablative and non-ablative laser direct-write processing of microstructures in metals, polymers, glasses and crystalline materials, and developments of time-resolved fluorescence detection of single cells using new laser sources are reported.

11:30am WeA2 — **High power Yb^{3+}-doped air-clad fibre laser using a Bragg grating written into the active medium**

M. Åslund, S. D. Jackson, J. Canning, N. Groothoff, B. Ashton, and K. Lyytikäinen. University of Sydney, Sydney (NSW), Australia

An air-clad fibre laser using a Bragg grating output coupler written directly into the Yb^{3+} doped core is presented. An unsaturated output power of 12 W is generated at a slope efficiency of 34 %.

11:45am WeA3 — **Injection-seeded pulsed optical parametric oscillator: Bandwidth control and dynamical processes**

R. T. White[a], Y. He[a], B. J. Orr[a], M. Kono[b], and K. G. H. Baldwin[b]. [a] Macquarie University, Sydney (NSW), Australia. [b] The Australian National University, Canberra (ACT), Australia

Dynamical processes in a nanosecond-pulsed optical parametric oscillator have been studied by an optical-heterodyne technique. We observe controllable phenomena, such as frequency chirp and variations in the spectral purity during each pulse, in real time.

12:00pm WeA4 — **Effects of non-equilibrium energy distribution of surface atoms on the onset and rate of laser ablation: Experiments and theory**

E. G. Gamaly[a], N. R. Madsen[a], M. W. Duering[a,b], A. V. Rode[a], V. Z. Kolev[a], and B. Luther-Davies[a]. [a] The Australian National University, Canberra (ACT), Australia. [b] Fraunhofer Institute for Laser Technology, Aachen, Germany

We demonstrate the effect of energy transfer from the high-energy tail of the Maxwellian distribution to the non-equilibrium surface layer on the onset and rate of a solid-gas phase transition in laser ablation experiments.

Batten 2 room

11:00am-12:45pm
WeB ■ Optical Fibres 2
Dr. Colin McKinstrie, Lucent-Bell Labs, Presider

11:00am WeB1 — **New age fibre crystals** **Invited**

P. Russell. University of Erlangen-Nuremberg, Erlangen, Germany

Photonic crystal fibres — glass strands with an array of tiny hollow channels running along their length — have ushered in a new age of fibre optics, with a multitude of applications spanning many areas of science.

11:45am WeB2 — **High resolution swept heterodyne spectrometer for NRZ data stream characterisation of MZ modulators**

R. Watts, N. Chang, and S. G. Murdoch. The University of Auckland, Auckland, New Zealand

We have developed a Swept Heterodyne Spectrometer with 0.05pm resolution and −80dBm sensitivity to aid the characterisation of NRZ data streams. We present measurements of NRZ data streams at 155Mb/s and repetitive NRZ bit patterns.

12:00pm WeB3 — **Direct observation of fast, high-contrast intensity noise of a contiuous wave fibre Raman laser**

J. Schroeder[a], F. Vanholsbeek[a], M. González-Herráez[b], and S. Coen[a]. [a] The University of Auckland, Auckland, New Zealand. [b] Institudo de Física Aplicada, CISC, Madrid, Spain

We observe fast intensity fluctuations on a few picoseconds time-scale in the output of a continuous wave Raman laser, by Raman pumping a signal of low repetition rate in a zero walk-off configuration.

12:15pm

WeA5 — Development of a polymer ablation and deposition system based on optical parametric amplification

V. Z. Kolev, M. W. Duering, B. Luther-Davies, K. T. Vu, and P. Smythe. The Australian National University, Canberra (ACT), Australia

We propose a high-power tuneable mid-infra-red source for Resonant Infra-Red Pulsed Laser Deposition of polymer materials. It is a three-stage laser system based on optical parametric amplification using MgO:PPLN crystals.

WeB4 — Surface-enhanced Raman scattering on nanostructured optical fibre tips

D. J. White, A. P. Mazzolini, and P. R. Stoddart. Swinburne University of Technology, Hawthorn (Victoria), Australia

We present an attractive method for producing precise, stable nanostructures on the tip of an optical fibre. Surface-enhanced Raman scattering enhancements of over 106 suggest that these fibres can address important chemical sensing applications.

12:30pm

WeA6 — Miniature tunable ultraviolet cerium fluoride lasers

H. Liu, D. J. Spence, and D. Coutts. Macquarie University, North Ryde (NSW), Australia

A tunable ultraviolet miniature cerium fluoride laser has been demonstrated with ultra-low threshold (0.8 μJ) and high efficiency 35 % from a low power frequency quadrupled microchip Nd laser, which generated sub-nanosecond pulses range from 306 nm $\sim$ 332 nm.

WeB5 — Spun highly birefringent photonic crystal fibre

K. Digweed, A. M. Michie, J. Canning, B. Ashton, M. Stevenson, J. Digweed, I. M. Bassett, and J. H. Haywood. University of Sydney, Eveleigh (NSW), Australia

Spin induced circular birefringence combined with inherently high linear birefringence results in elliptical birefringence. This enables Faraday rotation with a very stable effective Verdet constant that is highly desirable for applications such as current sensing.

Free afternoon (12:45pm–)

Thursday

Registration (open from 8:00am, foyer area)

Batten 1 & 2 room

9:00am–10:30am
ThJ ■ Joint session
Pr. Rob Ballagh, University of Otago, Presider

9:00am ThJ1 — **Glass as optical host** **Invited**

S. N. Houde-Walter. University of Arizona - Tucson, LaserMax, Inc, Rochester (NY), USA

An overview of structure-property relationships and the effect of impurities in multi-component optical glasses and glass-ceramics will be presented. The effect of impurities on energy transfer and their effective removal will also be given.

9:45am ThJ2 — **Control of coherent light: From precision spectroscopy to extreme nonlinear optics** **Invited**

J. Jones and J. Ye. National Institute of Standards and Technology and University of Colorado, Boulder (Colorado), USA

Phase control of wide-bandwidth optical frequency combs and supernarrow linewidth CW lasers have enabled amazing capabilities in optical frequency measurement and synthesis, optical atomic clocks, united time-frequency spectroscopy, coherent pulse synthesis and manipulation, and deterministic studies in sub-cycle physics.

Morning tea (10:30am–11:00am)

Batten 1 room

11:00am-12:30pm
ThA ■ Spectroscopy 2
Pr. Brian Orr, Macquarie University, Presider

11:00am ThA1 — **Making polar molecules at microKelvin** **Keynote**

W. C. Stwalley. University of Connecticut, Storrs (CT), USA

We have produced ultracold polar KRb molecules by photoassociation in the $X^1\Sigma^+$ ground and $a^3\Sigma^+$ metastable states. Using state-selective two-photon ionization, we have determined the rovibrational distributions in each electronic state.

Batten 2 room

11:00am-12:30pm
ThB ■ Cold Atoms & BEC 2
Dr. Matthew Collett, The University of Auckland, Presider

ThB1 — **"Classical" fields and Bose-Einstein condensates** **Keynote**

C. W. Gardiner[a], R. J. Ballagh[a], P. B. Blakie[a], A. A. Norrie[a], A. S. Bradley[b], and M. J. Davis[b]. [a] University of Otago, Dunedin, New Zealand. [b] University of Queensland, Brisbane (QLD), Australia

The application of the classical field method to Bose-Einstein condensation is reviewed, showing how it is now a quantitative and practical method. Criteria for validity and applications to the colliding condensates and the evaluation of the critical temperature will be discussed.

11:30am

ThA2 — Five-level lasing-without-inversion system in rubidiums

T. Meijer, J. D. White, B. Smeets, and R. E. Scholten. University of Melbourne (VIC), Australia

We demonstrate continuous coherent blue laser light production using a five-level lasing-without-inversion scheme in rubidium vapour, using two low-power lasers at 780 and 776nm. Substantially increased efficiency is obtained by coupling both hyperfine ground states.

ThB2 — Theory of strongly interacting ultracold fermions

P. D. Drummond, J. F. Corney, X. J. Liu, and H. Hui. The University of Queensland, Brisbane (QLD), Australia

Experiments on ultracold fermions can implement strongly interacting Fermi systems. We present theoretical results for a Gaussian phase-space method for fermions, techniques to calculate collective mode frequencies, and a theory of the BEC-BCS cross-over.

11:45am

ThA3 — Coherent heterodyne-assisted pulsed spectroscopy (CHAPS)

M. Kono[a], K. G. H. Baldwin[a], Y. He[b], R. T. White[b], and B. J. Orr[b]. [a] The Australian National University, Canberra (ACT), Australia. [b] Macquarie University, Sydney (NSW), Australia

The Doppler-free lineshape of 6S-8S two-photon excitation in cesium is measured by a new technique, Coherent Heterodyne-Assisted Pulsed Spectroscopy (CHAPS). This uses an injection-seeded pulsed optical parametric oscillator, close to the Fourier-transform limit.

ThB3 — Supersonic flows in dilute gas Bose-Einstein condensates

C. M. Savage, S. Wüster, T. Slatyer, and A. Reid. The Australian National University, Canberra (ACT), Australia

Supersonic flows in BECs are associated with negative energy anomalous modes. These suggest novel processes, related to Hawking radiation, that extract energy from the BEC, in the form of phonons, by populating anomalous modes.

12:00pm

ThA4 — Storage and retrieval of light pulses in "slow" and "fast" light media

A. Akulshin[a], A. Lezama[a,b], A. Sidorov[a], R. McLean[a], and P. Hannaford[a]. [a] Swinburne University of Technology, Hawthorn (Victoria), Australia. [b] Facultad de Ingenieria, Montevideo, Uruguay

We have experimentally demonstrated that the storage of light can occur in a coherent atomic medium with an associated negative group velocity. Retrieved optical pulses can only have exponentially decaying slope.

ThB4 — Anomalous heating of Bose-Einstein condensates in optical lattices

A. J. Ferris[a], M. J. Davis[a], P. B. Blakie[b], R. Geursen[b], and A. C. Wilson[b]. [a] University of Queensland, Brisbane (QLD), Australia. [b] University of Otago, Dunedin, New Zealand

"Anomalous" heating has been observed in dense Bose-Einstein condensates loaded into moving optical lattices. We explain this quantitatively in terms of the seeding of four-wave mixing by quantum fluctuations of the vacuum.

12:15pm

ThA5 — Dragon phototherapy — Using vibrational energy flow to combat disease

M. C. Simpson[a], J. R. Challa[a], H.-L. Peng[a], T. Gunaratne[b], A. Keilman[a], A. Drollinger[a], and M. Ahn[a]. [a] Case Western Reserve University, Cleveland (Ohio), USA. [b] Michigan State University, Lansing (Michigan), USA

Femtosecond spectroscopy is used to probe vibrational dynamics in hemes and para-nitroanilines to evaluate vibrational insulator and conductor behavior. A photothermal therapeutic paradigm is described. Preliminary results in solution, solvent nanopools, and cells is presented.

ThB5 — A detector for continuous measurement of ultra-cold atoms in real time

C. Figl[a], M. Jeppesen[a], L. Longchambon[b], M. Kruger[c], H.-A. Bachor[a], N. P. Robins[a], and J. D. Close[a]. [a] The Australian National University, Canberra (ACT), Australia. [b] Université Paris 13, Villetaneuse, France. [c] University of Missouri, USA

We present and characterize a shot-noise limited two-color Mach-Zehnder interferometer as a detector for high-bandwidth, minimally-destructive, real-time measurements of the atom number density in Bose Einstein condensates.

Lunch break (12:30pm–2:00pm)

Batten 1 room

2:00pm-3:45pm
ThC ■ Lasers 2
Pr. John Harvey, The University of Auckland, Presider

2:00pm

ThC1 — Towards terabit per second all-optical photonic integrated circuits **Keynote**

B. J. Eggleton. University of Sydney (NSW), Australia

The realization of photonic integrated circuits (PICs) operating at terabit/s (Tb/s) speeds is one of the holy grails of optical communications. In this paper I will review recent progress by CUDOS researchers in this field, based on highly nonlinear chalcogenide glass. The highlight of this research is the demonstration of the PIC all-optical signal regeneration with 1.5 ps pulses.

2:30pm

ThC2 — Tomographic wavefront sensors for advanced gravitational wave interferometers

A. Brooks, P. J. Veitch, and J. Munch. University of Adelaide, Adelaide (SA), Australia

We shall describe a high precision tomographic Hartmann wavefront sensor that can measure thermally-induced wavefront distortion and applied compensation in the mirrors of advanced gravitational wave interferometers, without interfering with the circulating optical power.

2:45pm

ThC3 — Femtosecond inscription of fibre Bragg gratings in active and passive fibres: The point-by-point method

G. D. Marshall and M. J. Withford. Macquarie University, Sydney (NSW), Australia

Fibre Bragg gratings were inscribed in non-sensitised passive and active optical fibres using a femtosecond laser and the point-bypoint method. Gratings with insertion losses of up to 53 dB were written.

3:00pm

ThC4 — Optically rewritable diffraction gratings in $RbCdF_3$:Mn^{2+} crystals

R. T. White[a], G. V. M. Williams[a], C. L. Dunford[a], S. Schweizer[b], B. Henke[b], and J. M. Spaeth[b]. [a] Industrial Research Ltd, Lower Hutt, New Zealand. [b] University of Paderborn, Germany

We take advantage of the unique optical properties of $RbCdF_3$:Mn^{2+} crystals to create erasable diffraction gratings. The gratings are written by a Hg lamp and a 325-nm laser and the diffraction is measured using a 325-nm laser.

Batten 2 room

2:00pm-3:45pm
ThD ■ Quantum Optics 2
Dr. Craig Savage, The Australian National University, Presider

2:00pm

ThD1 — Experiments towards a quantum information network with squeezed light and entanglement **Keynote**

W. P. Bowen. University of Otago, Dunedin, New Zealand

Progress towards the implementation of a quantum information network is presented. Experiments performed during the speakers Ph.d. investigating quantum polarisation states, Einstein-Podolsky-Rosen entanglement, quantum teleportation, and quantum optics with atomic ensembles are discussed.

2:30pm

ThD2 — Einstein, the EPR argument, and steering: New perspectives from quantum information

H. M. Wiseman[a], A. C. Doherty[b], and S. J. Jones[a]. [a] Griffith University, Australia. [b] The University of Queensland (QLD), Australia

In 1935 the nonlocality of the Copenhagen interpretation was pointed out by Einstein (the "EPR paradox") and by Schrödinger ("steering"). We reexamine these arguments from a quantum information perspective, and find a unified description.

2:45pm

ThD3 — Atomic motion and density fluctuations in cavity quantum electrodynamics

L. Horvath and H. J. Carmichael. The University of Auckland, Auckland, New Zealand

Limitations of the existing formulas for the intensity correlation function of many-atom cavity quantum electrodynamics are explored. Quantum trajectory simulations are carried out which remove the limitations and explain a long-standing disagreement between experiment and theory.

3:00pm

ThD4 — TEM_{10} homodyne detection as an optimal small displacement and tilt measurement scheme

V. Delaubert[a,b], N. Treps[a], C. C. Harb[b], P. K. Lam[b], and H.-A. Bachor[b]. [a] Laboratoire Kastler Brossel, Paris, France. [b] The Australian National University, Canberra (ACT), Australia

We experimentally demonstrate sub shot-noise small displacement and tilt measurement, involving a homodyne detection with a TEM_{10} local oscillator. We prove a 56 % detection efficiency improvement compared to the standard split detection.

3:15pm

ThC5 — Development of a sodium laser guide star for astronomical adaptive optics systems

T. P. Rutten, P. J. Veitch, and J. Munch. University of Adelaide, Adelaide (SA), Australia

The presentation will review the major problems associated with current laser guide star designs, discuss how our unique laser design can overcome these problems and include the promising results of our power scaleable, proof of principle laser.

ThD5 — Removing thermal photons from squeezed states

O. Glöckl[a], U. L. Andersen[a], W. P. Bowen[b], and G. Leuchs[a]. [a] Universität Erlangen-Nürnberg, Erlangen, Germany. [b] University of Otago, Dunedin, New Zealand

We present a scheme based on phase quadrature measurements and feed forward techniques to remove thermal photons from squeezed states with excess phase noise. This enhances their purity and makes the states more useful as quantum resources.

3:30pm

ThC6 — Feasibility of thermal tweezers for effective manipulation of nano-particles of surfaces

D. R. Mason, D. K. Gramotnev, A. Rasmussen, and G. Gramotnev. Queensland University of Technology, Brisbane (QLD), Australia

Anisotropic surface diffusion of nanoparticles is investigated in the presence of strong optically induced temperature gradients. Strong diffusive trapping of nanoparticles is predicted. Feasibility of thermal tweezers for effective manipulation of nanoparticles is discussed.

ThD6 — Activation and distillation of pure-state entanglement in quantum optics

S. D. Bartlett[a], A. C. Doherty[b], R. W. Spekkens[c], and H. M. Wiseman[d]. [a] The University of Sydney (NSW), Australia . [b] The University of Queensland (QLD), Australia. [c] Perimeter Institute for Theoretical Physics, Waterloo, Canada. [d] Griffith University (QLD), Australia

We demonstrate that, when parties lack a shared phase reference, several quantum optical states with confusing entanglement properties are analogous to bound entangled states, exhibiting exotic phenomena such as multi-copy distillation and activation.

Afternoon tea (3:45pm–4:00pm)

Rutherford room

4:00pm–5:30pm
ThP ■ Poster session

ThP1 — Photonic devices fabricated in bulk glass by femtosecond laser pulses

M. Ams, G. D. Marshall, J. A. Piper, and M. J. Withford. Macquarie University (NSW), Australia

Symmetric, low transmission loss waveguides and photonic devices are written in bulk glasses via a beam shaping technique and femtosecond laser pulses. The characteristics of these devices written in phosphate glass will be presented.

ThP2 — Transitions from stationary to pulsating solitons in passively mode-locked lasers

A. Ankiewicz[a], E. N. Tsoy[a,b], and N. Akhmediev[a]. [a] The Australian National University, Canberra (ACT), Australia. [b] Uzbek Academy of Sciences, Tashkent, Uzbekistan

Pulsating solitons occur in soliton lasers, as predicted by our group. A reduced system shows how amplitude, width and chirp evolve. It relates them to stable limit cycles and explains the transition from stationary solitons.

ThP3 — Power strippers made from collapsed air-clad fibres

M. Åslund[a], J. Canning[a], S. D. Jackson[a], J. S. Warwick[b], K. Lyytikäinen-Digweed[a], and J. Holdsworth[b]. [a] University of Sydney, Sydney (NSW), Australia. [b] University of Newcastle, Callaghan (NSW), Australia

We demonstrate optical access to the core of air-clad fibres by collapsing the air-silica microstructure cladding and making strippers. Results show that pump light can be stripped controllably at a rate of $\sim 50\,\%$ per fuse.

ThP4 — Bragg grating growth in chalcogenide rib-waveguides

N. J. Baker[a], M. Shokooh-Saremi[a], V. G. Ta'eed[a], I. C. M. Littler[a], D. J. Moss[a], C. M. de Sterke[a], B. J. Eggleton[a], Y. Ruan[b], and B. Luther-Davies[b]. [a] University of Sydney (NSW), Australia. [b] The Australian National University, Canberra (ACT), Australia

Growth dynamics of a Bragg grating are measured as a grating is written into a chalcogenide based waveguide. Excellent agreement is seen between the observed spectra and simulations based on coupled mode theory.

ThP5 — Generation of multi-nanomaterial colloids from ultrafast laser ablation

S. Barcikowski and B. Chichkov. Laser Zentrum Hannover e.V., Hanover, Germany

A high variety of nanoparticle dispersions and multi-material colloids can be produced by femtosecond laser ablation of the bulk material in liquids. Moreover, bimetallic nanoparticles may be generated in water using this method.

ThP6 — $Ca_3Sc_2Ge_3O_{12}$:Ni^{2+}: First-principles analysis of the energy level structure and absorption spectra

M. G. Brik, K. Ogasawara, and T. Ishii. Kwansei Gakuin University, Hyogo, Japan

First-principles analysis of the energy level structure and absorption spectra for Ni^{2+} ion at both possible positions (tetrahedral Ge^{4+} and octahedral Sc^{3+}) in $Ca_3Sc_2Ge_3O_{12}$:Ni^{2+} is performed. Discussion of the obtained results is given.

ThP7 — Crystal field analysis of the transition metal ions energy level schemes in laser crystals

M. G. Brik[a], *N. M. Avram*[b], *and C. N. Avram*[b]. [a] *Kwansei Gakuin University, Hyogo, Japan.* [b] *West University of Timisoara, Timisoara, Romania*

Consistent crystal field analysis of energy level schemes, ground and excited state absorption spectra of 3d-ions (Cr^{4+}, Cr^{3+}, V^{3+}, Ni^{2+}), electron-phonon interaction is performed for a large number of crystals. Comparison with experiments is discussed.

ThP8 — Lossy modes of 1D photonic crystal waveguides

S. Campbell[a], *L. Botten*[b], *R. McPhedran*[a], *and C. M. de Sterke*[a]. [a] *The University of Sydney, Sydney (NSW), Australia.* [b] *University of Technology, Sydney (NSW), Australia*

A method that can accurately and efficiently model loss in PC slab waveguides has been developed. Details of the method and preliminary results for a 1D photonic crystal slab will be presented.

ThP9 — Widely tunable optical parametric amplification in photonic crystal fibers

J. S. Y. Chen, S. G. Murdoch, R. Leonhardt, and J. D. Harvey. The University of Auckland, Auckland, New Zealand

Widely tunable parametric amplification in photonic crystal fibers with dispersion fluctuations is analyzed. The fluctuations are modeled as monotonic, stepwise and stochastic processes. This allows us to provide a measure of the uniformity of the fibers.

ThP10 — A simple method for fabricating toroidal microcavities

S. Cooper, M. Dalley, M. Fernée, B. Littleton, and H. Rubinsztein-Dunlop. University of Queensland, Brisbane (QLD), Australia

We present preliminary results on the performance of toroidal microcavities fabricated using a CO_2 laser. The mode structure of these devices is compared with that of similar sized microsphere resonators.

ThP11 — Quantum noise simulations of fibre squeezing

J. F. Corney and P. D. Drummond. The University of Queensland, Brisbane (QLD), Australia

We simulate propagation of ultrashort pulses in optical fibres, including all significant quantum and thermal noise. We calculate the optimal polarization squeezing and compare to recent experiments, with good quantitative agreement.

ThP12 — Fabrication of microchannels in PMMA under high repetition rate nanojoule femtosecond pulses

D. Day and M. Gu. Swinburne University of Technology, Hawthorn (Victoria), Australia

Microchannels are fabricated in a poly(methyl methacrylate) substrate by high repetition rate, nanojoule femtosecond laser pulses. The mechanism for channel fabrication is based on the localized heating of the substrate due to the high repetition rate of the laser.

ThP13 — Silica photonic crystal fibre fabrication and research in australia

K. Digweed-Lyytikäinen and J. Canning. University of Sydney, Eveleigh (NSW), Australia

OFTC at the University of Sydney is the only facility in the southern hemisphere producing cutting edge photonic crystal fibre and other air-structured fibre technologies. We review our capabilities and the state of the art research in these technologies both with our national and international colleagues.

ThP14 — Simulations of nonlinear response of molecules interacting with strong femtosecond two-colour laser pulses

M. T. T. Do[a], *L. V. Dao*[a], *P. Hannaford*[a], *and S. Pulkin*[a,b]. [a] *Swinburne University of Technology, Melbourne (Victoria), Australia.* [b] *Saint-Petersburg State University, Saint-Petersburg, Russia*

Programs have been developed for solving the density matrix equations for three- and four-level systems with inhomogeneous broadening in order to determine the nonlinear response of molecules interacting with strong femtosecond two-colour laser pulses.

ThP15 — Mode-locking characteristics of external cavity lasers

N. Dogru. University of Gaziantep, Gaziantep, Turkey

Repetition frequency range of hybrid soliton pulse source is significantly extended (1.3 GHz) by using linearly chirped raised-cosine flat top fiber Bragg grating.

ThP16 — Intensity modulation of fiber Bragg grating external cavity semiconductor lasers

N. Dogru and M. S. Ozyazici. University of Gaziantep, Gaziantep, Turkey

Resonance peak spectral splitting (RPSS) in intensity modulation response of hybrid soliton pulse source utilizing fiber Bragg gratings as external cavity is suppressed by introducing suitable linear chirp rate in Gaussian apodized gratings.

ThP17 — The effect of molecular aggregation on the fluorescence and photostability of "push-pull" hyperpolarisable chromophores

C. L. Dunford[a], G. J. Smith[b], A. Lowry[a], A. D. Woolhouse[a], and A. J. Kay[a]. [a] Industrial Research Ltd, Lower Hutt, New Zealand. [b] Victoria University of Wellington, Wellington, New Zealand

Hyperpolarisable organic molecules in polymers are of interest for use in nonlinear optical devices. However the very high concentrations required promote molecular aggregation. The resulting effects on photostability are explored.

ThP18 — High resolution spectroscopy using ground state coherence of ^{6}Li

J. Fuchs, G. Duffy, P. Hannaford, W. Rowlands, and A. Akulshin. Swinburne University of Technology, Melbourne (Victoria), Australia

We present high resolution spectroscopy of ^{6}Li. Sub-Doppler and sub-natural resolution have been achieved on both the D1 and D2 lines using velocity-selective optical pumping and light-induced hyperfine coherence.

ThP19 — A new type of metallic waveguide with strong sub-wavelength localisation for nano-plasmonics

D. K. Gramotnev[a], D. F. P. Pile[b], and K. C. Vernon[a]. [a] Queensland University of Technology, Brisbane (QLD), Australia. [b] The University of Tokushima, Tokushima, Japan

A new metallic sub-wavelength waveguide made of a gap in a thin metal film is analysed theoretically and numerically. Different types of leaky and non-leaky strongly localised guided modes and their physical interpretation are considered.

ThP20 — Light bullets and dynamic pattern formation in nonlinear dissipative systems

P. Grelu[a], J. M. Soto-Crespo[b], and N. Akhmediev[c]. [a] Université de Bourgogne, Dijon, France. [b] Instituto de Optica, CSIC, Madrid, Spain. [c] The Australian National University, Canberra (ACT), Australia

Using cubic-quintic Ginsburg-Landau equation and localized initial conditions, we study propagation of (3+1)D optical light bullets in dissipative media. Depending on the model parameters, we observe stable light bullet propagation or higher-order transverse pattern formation.

ThP21 — Imaginary-distance beam propagation simulations of highly nonlinear photonic crystal fibres

S. Ha, R. J. Kruhlak, G. K. L. Wong, and J. D. Harvey. The University of Auckland, Auckland, New Zealand

Simulations using realistic index profiles of photonic crystal fibres confirm that the phase and group birefringence are of the opposite sign and both have a significant wavelength dependence. The simulations compare well with experimental results.

ThP22 — A low-cost differential absorption lidar for tropospheric water vapour measurements

M. W. Hamilton[a], Y. Mao[a], Z. Yu[a], R. A. Vincent[a], and R. Atkinson[b]. [a] University of Adelaide, Adelaide (SA), Australia. [b] Australian Bureau of Meteorology, Melbourne (VIC), Australia

We present progress in the development of a low-cost differential absorption lidar system for measuring water vapour concentrations in the lower troposphere.

ThP23 — Continuous-wave cavity ringdown spectroscopy for real-time sensing of multiple gas species

Y. He, F. V. Englich, and B. J. Orr. Macquarie University, Sydney (NSW), Australia

Continuous-wave cavity ringdown spectrometers based on either a swept cavity or a widely tunable swept-frequency laser are developed for real-time spectroscopic sensing of multiple species. We discuss various factors affecting detection sensitivity and describe applications.

ThP24 — Er:Yb:glass laser for coherent lidar

M. C. Heintze, J. Munch, and P. J. Veitch. University of Adelaide, Adelaide (SA), Australia

We shall describe the development and operation of a diode-pumped Er:Yb:glass laser for use in coherent laser radar applications. This laser operates in the eye-safe band, allowing increased pulse energy and thus greater range.

ThP25 — Measurement of pressure induced shifts within saturated absorption spectroscopy

D. J. Hopper and E. A. Jaatinen. Queensland University of Technology, Brisbane (QLD), Australia

Rigorous investigation into the frequency shift due to influencing parameters such as pressure, cell length, and modulation frequency, is performed for a number of wavelengths for the purpose in developing corrective error in frequency measurements.

ThP26 — 10W Nd:YAG laser for gravitational wave interferometry

D. J. Hosken, D. Mudge, P. J. Veitch, and J. Munch. University of Adelaide, Adelaide (SA), Australia

We shall describe the development and characterisation of an injection-locked 10W Nd:YAG laser. The laser is compact and reliable, and has low intensity and frequency noise.

ThP27 — Is a 3-D model necessary in saturated absorption spectroscopy ?

E. A. Jaatinen and D. J. Hopper. Queensland University of Technology, Brisbane (QLD), Australia

A 3-D model of the interaction between a saturable absorber and pump and probe light fields is presented. Implications on the frequency uncertainty of lasers locked to saturated absorption signals are discussed.

ThP28 — Laser machined topographical structures for poling ferroelectrics

B. Johnston and M. J. Withford. Macquarie University, Sydney, North Ryde (NSW), Australia

We report on an investigation into a study of poling ferroelectric crystals using laser machined topographical structures to define the domain pattern. Laser machining aspects and modeling of the electrostatics of topographical structures is presented.

ThP29 — Influence of internal losses on reflectance spectra of non-uniform linearly chirped fibre Bragg gratings

D. J. Kitcher[a], A. Nand[a], S. A. Wade[a,b], G. W. Baxter[a], and S. F. Collins[a]. [a] Victoria University, Melbourne (VIC), Australia. [b] Monash University, Clayton (VIC), Australia

The response of chirped fibre Bragg gratings to forward-propagating and counter-propagating light is considered in terms of the transfer matrix approximation of the coupled mode theory.

ThP30 — Formation and detection of ultracold Rb dimers

H. Kitson, G. Veeravalli, and W. Rowlands. Swinburne University of Technology, Melbourne (VIC), Australia

The production and detection of ultracold Rb dimers from photoassociation in a magneto-optical trap is investigated. Dimers are photoionised and detected with time of flight discrimination on a channeltron.

ThP31 — Collisional quenching of spin-orbitally excited atomic chlorine studied by laser-induced fluorescence techniques in the vacuum ultraviolet energy region

M. Kono[a], K. Takahashi[b], and Y. Matsumi[b]. [a] The Australian National University, Canberra (ACT), Australia. [b] Nagoya University, Aichi, Japan

Rate constants for the collisional quenching of spin-orbitally excited $Cl(^2P_{1/2})$ atoms by H_2O, D_2O, and H_2O_2 were determined at $\sim$ 295 K using laser-flash photolysis and laser-induced fluorescence techniques in the vacuum ultraviolet energy region.

ThP32 — Polarization modulation instability gain characterization of a photonic crystal fibres

R. J. Kruhlak[a], J. S. Y. Chen[a], G. K. L. Wong[a], S. G. Murdoch[a], J. D. Harvey[a], and N. Y. Joly[b]. [a] The University of Auckland, Auckland, New Zealand. [b] University of Bath, Claverton Down, Bath, United Kingdom

We have characterized the polarisation modulation instability (PMI) gain in a photonic crystal fibre (PCF) for both slow and fast axis pumping. These results show that tunable, single-material PCF amplifiers are obtainable using PMI gain.

ThP33 — Non-classical behavior of external cavity diode laser by photons self-mixing with dual spatial modes

P. Kumar[a], R.Ghosh[a], and B. P. Singh[b]. [a] Jawaharlal nehru University, New Delhi, India. [b] Indian institute of technology Bombay, Mumbai, India

We have experimentally demonstrated and studied in detail the non-classical behavior of external cavity diode laser via photons self mixing process with dual spatial modes within the diode laser cavity having homogenous broadened gain medium. we got the correlation between the modes decreases as feedback strength from second cavity as well as spatial mode spacing increases. so laser transition from classical to quantum regime takes place.

ThP34 — Fabrication of long lengths of fibre with co-drawn electrode wire and electrically conductive coating suitable for thermal poling

K. Lee, P. Henry, and S. Fleming. University of Sydney, Sydney (NSW), Australia

We report the successful integration of recently published methodologies to produce long lengths of fibre suitable for poling. 90m of optical fibre with one internal wire electrode co-drawn, with an electrically conductive coating was drawn.

ThP35 — Porphyrin detection in a photonic crystal fibre

C. Martelli, J. Canning, K. Digweed, D. Stocks, and M. J. Crossley. University of Sydney, Eveleigh (NSW), Sydney

The detection of a 8.77×10^{-5}M solution of 4STPP-Mn-(OAc)2 porphyrin in distilled water using a photonic crystal fibre is presented. The in-fibre measured absorption curve is found to be in agreement with bulk results.

ThP36 — Refractive index measurement during ice 1h formation within a photonic crystal fibre using short wavelength diffraction

C. Martelli[a], *J. Canning*[a], *and M. Kristensen*[b].
[a] *University of Sydney, Eveleigh (NSW), Sydney.*
[b] *University of Aarhus, Århus, Denmark*

Short wavelength diffraction in photonic crystal fibres is used to study Ice 1h formation within the fibre. The estimated refractive index of ice is found to be in agreement with bulk results.

ThP37 — An Er-doped superfluorescent fibre source with polarisation stable mean wavelength

M. Matar, I. M. Bassett, J. H. Haywood, and A. M. Michie. University of Sydney, Eveleigh (NSW), Australia

Polarisation stability of the mean wavelength better than 2 ppm was achieved by adding a 3-section Lyot depolariser to a Er-doped Superfluorescent fibre source.

ThP38 — Ar-Ne* collision measurements using a Ne* MOT

K. J. Matherson, L. J. Byron, and R. T. Sang. Griffith University, Nathan (QLD), Australia

Results will be presented for measurement of the ejection of trapped atoms by elastic scattering using argon at thermal energies from a metastable Neon magneto-optical trap.

ThP39 — A comparison of tuneable dual-polarisation Nd:ceramic YAG and crystalline Nd:YAG lasers

A. McKay, J. M. Dawes, P. Dekker, and D. Coutts. Macquarie University, Sydney, North Ryde (NSW), Australia

We report a tuneable photonic microwave source based on a Nd:ceramic YAG laser in a two-frequency regime. Comparison of the beat-note characteristics of a crystalline and ceramic Nd:YAG laser is made and discussed in relations to Lamb's coupling constant.

ThP40 — Characterisation of thermally poled twin-hole silica fibre over a broad wavelength range

A. M. Michie[a], *K. Digweed*[a], *J. Ingram*[b], *I. M. Bassett*[a], *and J. H. Haywood*[a]. [a] *University of Sydney, Eveleigh (NSW), Australia.* [b] *ABB-PTPH, Moorebank (NSW), Australia*

The linear electro-optic effect in thermally poled twin-hole fibre has been characterised versus wavelength. The increase in mode-field diameter with increasing wavelength enabled probing the region around the fibre core and into the inner cladding.

ThP41 — Second harmonic generation in a boron-containing liquid crystalline compound

A. Miniewicz[a,b], *A. Samoc*[a], *M. Samoc*[a], *A. Januszko*[c], *and P. Kaszynski*[c]. [a] *The Australian National University, Canberra (ACT), Australia.*
[b] *Wroclaw University of Technology, Wroclaw, Poland.*
[c] *Vanderbilt University, Nashville (TN), USA*

Second harmonic generation (SHG) has been studied in a boron containing liquid crystal. The phase transition from crystalline to nematic phase at 110^{o}C is marked with a drop of the SHG signal.

ThP42 — A high power, double-clad, cw Nd:YAG slab laser for advanced interferometric detectors

D. Mudge, P. J. Veitch, and J. Munch. University of Adelaide, Adelaide (SA), Australia

We present a high power continuous wave Nd:YAG laser that uses a new end pumped, side cooled, composite slab gain medium. The slab optimizes the gain distribution while minimizing thermal lensing and thermally induced birefringence.

ThP43 — Near infra-red transmission through annular apertures in thin silver films

S. M. Orbons[a], *D. Freeman*[b], *B. Luther-Davies*[b], *D. N. Jamieson*[a], *and A. Roberts*[a]. [a] *University of Melbourne, Melbourne (VIC), Australia.* [b] *The Australian National University, Canberra (ACT), Australia*

The effect of film thickness on near infra-red transmission through sub-wavelength annular apertures in thin silver films is investigated, with theoretical predictions being compared to experimental results.

ThP44 — A highly focused metastable neon beam for metastable de-excitation spectroscopy

A. J. Palmer, M. Baker, and R. T. Sang. Griffith University, Nathan (QLD), Australia

We present an approach for metastable de-excitation spectroscopy using a highly focused, laser-cooled metastable neon beam. Future plans to develop this beam into an atom microscope will be detailed.

ThP45 — Nearly 100 % transmission through sharp bends and T-junctions in gap plasmon waveguides with sub-wavelength localisation

D. F. P. Pile[a] *and D. K. Gramotnev*[b]. [a] *The University of Tokushima, Tokushima, Japan.* [b] *Queensland University of Technology, Brisbane (QLD), Australia*

Feasibility of nearly 100 % transmission through sharp bends and T-junctions in gap plasmon waveguides with strong sub-wavelength localisation is demonstrated numerically. Optimisation of the proposed structures and interpretation of the obtained results are presented.

ThP46 — Numerical analysis of coupled wedge plasmons in a structure of two wedges separated by a gap

D. F. P. Pile[a], *D. K. Gramotnev*[b], *and M. Haraguchi*[a]. [a] *The University of Tokushima, Tokushima, Japan.* [b] *Queensland University of Technology, Brisbane (QLD), Australia*

Coupling between two strongly localised wedge plasmons across a gap between two metal wedges is analysed numerically. Field structure, dispersion, and dissipation are determined as functions of wedge angle. Applications in plasmonics are discussed.

ThP47 — Measurements of the scattering length of spin-polarized metastable He^4 using photoassociation spectroscopy

M. Portier, S. Moal, J. Kim, J. Dugué, M. Leduc, and C. Cohen-Tannoudji. Ecole Normale Supérieure, Paris, France

Measurements of the scattering length a of spin-polarized metastable He^4 using photoassociation (PA) spectroscopy (light-induced frequency-shifts measurements, frustrated photoassociation, Raman spectroscopy).

ThP48 — The characterisation of pharmaceutical compounds through second harmonic generation

C. B. Rawle[a], *C. J. Lee*[a], *T. Rades*[b], *and P. J. Manson*[a]. [a] *University of Otago, Dunedin, New Zealand.* [b] *School of Pharmacy, Dunedin, New Zealand*

One of the problems in drug development is rapid physiochemical characterisation. The results of measuring the nonlinear optical properties of pharmaceutically interesting compounds are presented in this poster.

ThP49 — Dispersion of the complex third-order polarizability and two-photon cross section of molecules of bis-MSB

A. Samoc and M. Samoc. The Australian National University, Canberra (ACT), Australia

Complex cubic hyperpolarizability of bis-methylstyrylbenzene (bis- MSB) was evaluated in a wide wavelength range by femtosecond Z-scan in order to assess the suitability of this dye as a standard for the determination of two-photon absorption cross-sections.

ThP50 — Host composition effects on the luminescence decay of the $^3F_4$ and $^3H_4$ energy levels of Tm^{3+}-doped silica fibres

D. A. Simpson[a], *G. W. Baxter*[a], *S. F. Collins*[a], *B. Dussardier*[b], *G. Monnom*[b], *and W. Blanc*[b]. [a] *Victoria University, Melbourne (VIC), Australia.* [b] *Université de Nice – Sophia Antipolis, Nice, France*

Non-exponential decays are observed from the $^3F_4$ and $^3H_4$ energy levels in two different types of Tm^{3+}-doped-silica fibres. The effect of the host composition on the non-exponential nature of these decays is studied.

ThP51 — A gain-switched laser diode pulse source using a nonlinearly chirped grating

M. H. Song[a], *D. Reid*[a], *L. P. Barry*[b], *G. D. Edvell*[c], *and J. D. Harvey*[a]. [a] *The University of Auckland, Auckland, New Zealand.* [b] *Dublin City University, Ireland.* [c] *Redfern Optical Components, Australia*

5 ps transform limited pulses with pedestal suppression in excess of 45dB using a technology based on externally injected gain-switched laser in conjunction with a nonlinearly chirped fibre Bragg grating (NC FBG) is demonstrated.

ThP52 — Controlling the thermo-optic coefficient within a photonic crystal fibre

H. R. Sørensen[a] *and J. Canning*[b]. [a] *Danish Technical University, Lyngby, Denmark.* [b] *University of Sydney, Sydney (NSW), Australia*

The holes of a photonic crystal fibre define "metamaterial" properties experienced by traveling optical modes. Selection and tailoring the material within the hole and the distribution and size of holes, allows the thermooptic coefficient to be adjusted.

ThP53 — In-fibre optical attenuators using photonic crystal fibre

M. Stevenson[a], *C. Martelli*[a,b], *J. Canning*[a], *B. Ashton*[a], *and K. Digweed*[a]. [a] *University of Sydney, Eveleigh Sydney (NSW), Australia.* [b] *University of Sydney, Sydney (NSW), Australia*

A simple method for making fixed, in-fibre optical attenuators is accomplished using a standard commercial fusion splicer to collapse the air-silica structure of photonic crystal fibre. Results show an adjustable attenuation range of 0–31dB.

ThP54 — Tuning planer defects embedded within three-dimensional photonic crystals using one-dimensional lattices

M. J. Ventura, M. Straub, and M. Gu. Swinburne University of Technology, Hawthorn (Victoria), Australia

Tunable microcavities embedded in woodpile photonic crystals were generated by femtosecond-laser direct writing in a solid polymer. Fine tuning of the cavities were achieved through the introduction of further elements.

ThP55 — Adiabatic nano-focusing of plasmons in sharp metallic wedges

K. C. Vernon and D. K. Gramotnev. Queensland University of Technology, Brisbane (QLD), Australia

Nano-focusing beyond the diffraction limit is predicted for plasmons travelling in sharp nano-sized metallic wedges, with possible applications to coupling of light into sub-wavelength waveguides, near-field microscopy, and development of new sensors and measurement techniques.

ThP56 — Channel plasmon-polaritons in a metallic V-groove filled with dielectric

K. C. Vernon[a], D. F. P. Pile[b], and D. K. Gramotnev[a]. [a] Queensland University of Technology, Brisbane (QLD), Australia. [b] The University of Tokushima, Tokushima, Japan

Propagation and field structure of strongly localised channel plasmon-polaritons in a V-shaped metallic groove filled with dielectric are analysed numerically. The effect of the dielectric permittivity in the groove on plasmon propagation parameters is investigated.

ThP57 — Does adiabatic nano-focusing in metallic tips and nano-holes really exist?

M. Vogel and D. K. Gramotnev. Queensland University of Technology, Brisbane (QLD), Australia

Strong adiabatic nano-focusing in sharp metallic tips and conical nano-holes is analysed in the presence of dissipation in the metal. Conditions for nano-focusing are determined in both tips and holes.

ThP58 — Resonance enhanced two photon absorption in CdSe/ZnS QD films and InAs p-doped QDs

R. Watts[a], L. Wang[b], R. Jain[b], and J. D. Harvey[a]. [a] The University of Auckland, Auckland, New Zealand. [b] The University of New Mexico, Albuquerque, USA

We have measured the TPA-related florescence from excited InAs QDs, revealing a four orders of magnitude dynamic range, and CdSe/ZnS core/shell QD films, showing a times two improvement in TPA coefficient, β.

ThP59 — Study of the effect of copper electrodes on efficiency in a large bore copper vapor laser

M. Zand. Atomic Organization of Iran, Tehran, Iran

In this study, the effect of the copper electrodes in a large bore CVL has been studied. The obtained laser efficiency is more than 1 % and the average output power is more than 30 Watts.

ThP60 — Flip-flop thyratrons structure used in metal vapor laser power supplies

M. Zand, D. Salehinia, K. Khorasani, and B. Kia. Laser Research Center, Tehran, Iran

In this study, the design and operational performances of a shared frequency-paralleled double thyratron, model TGI1 1000/25, in Metal Vapor Lasers are presented. Average current and heat dissipation are half valued compared to single thyratron configuration.

ThP61 — Absorption and emission characteristics of thulium doped silica fibre

V. Zeqaj[a], D. A. Simpson[a], T. B. Nguyen[a], G. W. Baxter[a], S. F. Collins[a], W. Blanc[b], B. Dussardier[b], and G. Monnom[b]. [a] Victoria University, Melbourne (VIC), Australia. [b] Université de Nice – Sophia Antipolis, Nice, France

Measurements of absorption and emission spectra in thulium-doped silica fibres containing various amounts of aluminium and germanium dopants are presented, to assist our understanding of fibre lasers for wavelengths between 1600 and 2000 nm.

ThP62 — Fabrication and characterisation of 3D photonic crystals in lithium niobate by use of femtosecond laser-induced microexplosion

G. Zhou and M. Gu. Swinburne University of Technology, Hawthorn (Victoria), Australia

We report the generation of voids in a high refractive index lithium niobate crystal by using femtosecond laser induced microexplosion method. 16-layer FCC photonic crystals with $\sim 30\,\%$ bandgaps are fabricated by using a near-threshold fabrication method.

ThP63 — Quantum dynamics and correlations in BEC

P. D. Drummond, P. Deuar, M. R. Dowling, and M. J. Davis. The University of Queensland, Brisbane (QLD), Australia

Dynamical quantum correlations of Bose condensates are simulated from first principles. The physical quantities calculated are correlation waves formed after a dynamical switch in the couping constant, and correlated pairs emitted during four-wave mixing.

Conference dinner (6:30pm, Rutherford room)

Friday

Batten 1 & 2 room

9:00am–10:30am
FrJ ■ Joint session
Pr. Hans Bachor, The Australian National University, Presider

9:00am FrJ1 — **Entanglement and transfer of quantum information with trapped Ca^+ ions** **Invited**

R. Blatt. Universität Innsbruck, Innsbruck, Austria

Quantum information is stored and manipulated in strings of trapped Ca^+ ions. We have generated entangled states of up to eight particles using an algorithmic procedure and verified genuine multi-partite entanglement using state tomography.

9:45am FrJ2 — **Dissipative dynamics of spins in quantum dots** **Invited**

F. B. Brito[a], A. O. Caldeira[a], G. Medeiros-Ribeiro[b], and H. Westfahl, Jr.[b]. [a] Universidade Estadual de Campinas, Campinas (SP), Brazil. [b] Laboratório Nacional de Luz Síncrotron - ABTLuS, Campinas (SP), Brazil

Based on the theory of dissipative two level systems, we study the dynamics of the spin of an electron trapped in a self assembled quantum dot. We derive a particular Bloch-Redfield equation for the specific model where the electronic spin is coupled to acoustic phonons via the spin-orbit interaction and succeed in obtaining analytical solutions for the relevant time scales.

Morning tea (10:30am–11:00am)

Batten 1 room

11:00am-12:15pm
FrA ■ Cold Atoms & BEC 3
Dr. Andrew Wilson, University of Otago, Presider

11:00am FrA1 — **Atom chips: A vision for quantum information processing** **Keynote**

E. Hinds. Imperial College, London, UK

It is now possible to confine and manipulate cold atoms and Bose Einstein condensates in extremely small traps and single-mode matter wave guides. In combination with microscopic optical structures, these could provide the basis for realising quantum memories, interconnects and logic gates. I describe our progress in this direction at Imperial College.

Batten 2 room

11:00am-12:15pm
FrB ■ Quantum Optics 3
Dr. Steve Bartlett, University of Sydney, Presider

11:00am FrB1 — **Solitons in discrete systems: Controlling light with light** **Keynote**

R. Morandotti[a], H. S. Eisenberg[b], D. Mandelik[b], Y. Lahini[b], Y. Silberberg[b], M. Sorel[c], C. R. Stanley[c], J. S. Aitchison[d], D. Modotto[e], D. Cheskis[f], I. Ilsar[f], Y. Linzon[f], and S. Bar-Ad[f]. [a] INRS-EMT, Varennes, Canada. [b] Weizmann Institute of Science, Rehovot, Israel. [c] University of Glasgow, Glasgow, Scotland. [d] University of Toronto, Toronto (Ontario), Canada. [e] Universita' di Brescia, Brescia, Italy. [f] Tel Aviv University, Tel Aviv, Israel

Nonlinear waveguide arrays can support discrete solitons, which propagate along the array while maintaining their spatial profile. Experiments showing similarities and differences with continuous spatial solitons will be described.

11:30am

FrA2 — Outcoupling from a Bose-Einstein condensate with squeezed light to produce entangled atom laser beams.

S. A. Haine and J. J. Hope. The Australian National University, Canberra (ACT), Australia

We show that entangled atom laser beams can be produced by outcoupling from a Bose-Einstein condensate with squeezed light, and investigate the possibility of producing entanglement between the outcoupled atoms and the transmitted light.

FrB2 — Solid-state optical centres for quantum optics

M. J. Sellars, J. J. Longdell, E. Fraval, A. L. Alexander, and N. B. Manson. The Australian National University, Canberra (ACT), Australia

The use of solid-state optical centres for ensemble based quantum optics applications such as quantum memories, single photon sources and quantum memories is investigated.

11:45am

FrA3 — Lattice solitons of a spinor Bose-Einstein condensate

B. J. Dąbrowska, T. J. Alexander, and Y. S. Kivshar. The Australian National University, Canberra (ACT), Australia

We consider a spinor Bose-Einstein condensate of ^{87}Rb with a *ferromagnetic* spin-dependent interaction, and show that in an optical lattice the condensate may form multi-component solitons with both ferromagnetic and *polar* spin structures.

FrB3 — Quantum noise limited amplitude and phase quadratures information delay via electromagnetically induced transparency

M. T. L. Hsu, J. J. Longdell, G. Hétet, H.-A. Bachor, and P. K. Lam. The Australian National University, Canberra (ACT), Australia

We demonstrate a quantum noise limited delay ($\sim c/12000$) of the amplitude and phase quadratures of a continuous wave optical beam via EIT in a Rubidium vapour cell. Insignificant cross-quadrature coupling between the amplitude and phase quadratures have also been shown.

12:00pm

FrA4 — Atom number superselection rule: An ultracold atom-molecule analogue of the Aharonov-Susskind experiment

M. R. Dowling[a], T. Rudolph[b], and R. W. Spekkens[c]. [a] The University of Queensland (QLD), Australia. [b] Imperial College London, London, UK. [c] Perimeter Institute for Theoretical Physics, Waterloo, Canada

We present an analogue of the Aharonov-Susskind charge superselection rule experiment with ultracold atoms and molecules. The superselection rule in question is for atom number and the experiment may be feasible with current techniques.

FrB4 — Quantum weak values of single photon polarization

G. J. Pryde[a], J. L. O'Brien[a], T. C. Ralph[a], A. G. White[a], and H. M. Wiseman[b]. [a] University of Queensland, Brisbane (QLD), Australia. [b] Griffith University, Brisbane (QLD), Australia

We experimentally determine weak values for a single photon's polarization, obtained via weak measurement that employs a twophoton entangling operation, and post-selection. The weak value of the Stokes parameter lies far outside the operator's spectrum.

Conference conclusion (12:15pm)

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