24th Australian Institute of Physics Congress

Sunday, 11 December 2022 - Friday, 16 December 2022

Book of Abstracts

Contents

7th International Workshop on Speciality Optical Fibres / 7

Molten core fiber fabrication: Opening up the Period Table

Author: John Ballato[None]

This invited talk will discuss the molten core method for fabricating a wide variety of novel glassy and crystalline core optical fibers, exhibiting an equally wide variety of fascinating properties not previously known

Poster session / 10

Shell effects in fission and quasifission

Author: Cedric Simenel[None]

We use static and time-dependent mean-field approaches to investigate and compare the shell effects affecting fragment formation in both fission and quasifission.

AIP: Theoretical and Mathematical / 11

Fermions with long and finite-range interactions on a quantum ring

Authors: Alexander Bray[None]; Cedric Simenel[None]

A quantum ring model of same spin fermions is developed. Quantum Monte Carlo calculations are performed. Comparisons with analytical Hartree-Fock solutions are used to get an insight into the role of correlations.

AIP: Nuclear and Particle Physics / 12

Impact of nuclear structure on nuclear responses to WIMP elastic scattering

Authors: Raghda Abdel Khaleq[None]; Andrew Stuchbery[None]; Cedric Simenel[None]

We highlight the potential uncertainties that may arise from the nuclear components of WIMP-nucleus scattering amplitudes, due to nuclear structure theory within the framework of the nuclear shell model.

Poster session / 13

Volatile Crystalline Semiconductor Core Fibers

Author: Thomasina Zaengle[1]

Co-authors: Thomas Hawkins [2]; Ursula Gibson [2]; Colin McMillen [2]; Basanta Ghimire [2]; Apparao Rao [2]; John Ballato [3]

[1] *Clemson University Graduate Student*

[2] *Clemson University*

[3] *Advisor*

Through the use of the flux-assisted molten core method, semiconductor core fibers (GaAs and ZnSe), that cannot be directly melted at ambient pressure due to intrinsic volatility have been fabricated into meters of fiber.

Poster session / **15**

Techno-economic comparison for productions of hydrogen and synthetic methane from Australian wheat straw

Author: Ross Swinbourn[1]

Co-authors: Feng Wang [1]; Chao'en Li [2]

[1] *Swinburne University of Technology*

[2] *CSIRO*

Preliminary results on the generation of hydrogen and methane from Australian wheat straw.

Poster session / **16**

Bouncing droplets and liquid time crystals

Author: Tapio Simula[None]

We have established a new Australian research laboratory dedicated for studies of gravitationally bouncing droplets of fluid. In this inaugural work we have created and observed long-lived and interacting time crystals.

AIP: Atomic and Molecular Physics / **17**

Gravitation, quantum computing and quantised vortices

Authors: Emil Génetay Johansen[1]; Rama Sharma[1]; Tapio Simula[None]

[1] *Swinburne University of Technology*

This is theoretical work on quantised vortices in superfluids with a specific focus on connections between the theory of rotating neutral superfluids, topological quantum computation, and gravitation endowed by an acoustic metric.

AIP: Quantum Science and Technology / **18**

Superabsorption in an organic microcavity: towards a quantum battery

Author: James Quach[None]

We implement experimentally a paradigmatic model of a quantum battery, constructed of a microcavity enclosing a molecular dye.

Precision and Quantum Sensing Workshop / 19

Development & Performance of a Portable Dual-Colour Two-Photon Rb Clock

Authors: Sarah Scholten[1]; Clayton Locke[2]; Nicolas Bourbeau Hebert[2]; Emily Ahern[2]; Ben White[2]; Christopher Billington[2]; Ashby Hilton[2]; Montana Nelligan[2]; Jack Allison[2]; Rachel Offer[2]; Elizaveta Klantsataya[2]; Christopher Perrella[2]; Andre Luiten[2]

[1] *Institute for Photonics and Advanced Sensing, University of Adelaide*

[2] *University of Adelaide*

We demonstrate the in- and out-of-lab performance of the first automated, portable, dual-colour two-photon optical rubidium clock with integrated comb. Fractional frequency instabilities of $1.3 \times 10^{-13}/\sqrt{\tau}$ for $1\text{s} < \tau < 1000\text{s}$, crossing the 10^{-15} regime at $\tau = 200\text{s}$, are achieved.

7th International Workshop on Speciality Optical Fibres / 20

Interrogation of distributed feedback fibre laser over 100 km

Author: Scott Foster[1]

Co-authors: Alex Zinoviev [1]; Joanne Harrison ; Jonathan Hedger [2]

[1] *DSTG*

[2] *Institute for Photonics and Advanced Sensing and School of Physical Sciences, University of Adelaide*

Using interferometric interrogation techniques, we demonstrate measurement of the frequency noise of 4 multiplexed distributed feedback fiber lasers over a 100 km single mode fibre link.

Poster session / 21

HF Radar Signatures of Surface Gravity Wave Spectra on Shear Flows

Author: Stuart Anderson[1]

[1] *University of Adelaide*

We develop a radar scattering theory for time-varying surfaces with anisotropic dispersion relations, and apply it to the problem of remote sensing of flows generated by internal gravity waves in the ocean.

Poster session / **22**

Quench dynamics of trapped many-body systems.

Author: Alex Kerin[None]

Co-author: Andy Martin [1]

[1] *University of Melbourne*

We consider harmonically trapped systems of two and three bodies interacting via a contact interaction and present semi-analytic calculations of time-dependent observables, Ramsey signal and particle separation, following a quench in s-wave scattering length.

AIP: Quantum Science and Technology / **23**

Gaussian Boson Sampling experiments with displacements and time-bin encoding

Author: Raj Patel[1]

Co-authors: Santiago Sempere-Llagostera [1]; Guillaume Thekkadath [1]; Bryn Bell [1]; Steve Kolthammer [1]; Myungshik Kim [1]; Ian Walmsley [1]

[1] *Imperial College London*

Gaussian Boson Sampling (GBS) is a prominent model of quantum computing. We experimentally demonstrate both GBS with displacements and with time-bin encoding for the first time. The latter is used to search for dense sub-graphs.

AIP: Nuclear and Particle Physics / **24**

On the determination of uncertainties in parton densities

Author: Nicholas Hunt-Smith[None]

Co-authors: Alberto Accardi [1]; Anthony Thomas ; Martin John White [2]; Wally Melnitchouk [3]; nobuo sato [4]

[1] *Hampton U. and Jefferson Lab*

[2] *University of Adelaide (AU)*

[3] *Jefferson Lab*

[4] *jlab*

We review various methods used to estimate uncertainties in parton distribution functions (PDFs), finding that utilizing a neural network on a simplified example of PDF data has the potential to inflate uncertainties.

AIP: Nuclear and Particle Physics / **25**

Latest results from the ATLAS experiment at the CERN LHC

Author: Paul Jackson[1]

[1] *University of Adelaide*

This contribution will summarise results from the ATLAS Experiment at the CERN Large Hadron Collider related to the Higgs boson, top quarks and various searches for the beyond the Standard Model phenomena.

Australian and New Zealand Conference on Optics and Photonics / 27

Dispersion Engineering for Complete Coherent Conversion

Authors: Alexander Solntsev[1]; Sergey Batalov[2]; Nathan Langford[1]; Andrey Sukhorukov[3]

[1] *University of Technology Sydney*

[2] *Ural Federal University*

[3] *The Australian National University*

We show theoretically how to control coherent conversion between a narrowband pump photon and broadband photon pairs in nonlinear optical waveguides by tailoring frequency dispersion for broadband quantum frequency mixing.

AIP: Education / 28

“Chegg-proofing” Examination Setting

Author: Deb Kane[None]

Can a “Chegg-proof” examination of a standard physics unit be set? The answer, of course, is yes. But at what cost in academic workload, and is this the best use of that time?

Joint session: AIP-BMP / COMMAD / 30

Engineering of Plasmoinc Nanomaterials for Surface-enhanced Raman Scattering-based in vitro Cancer Diagnosis

Author: Yuling Wang[1]

[1] *Macquarie University*

As plasmonic nanomaterials play critical roles in facilitating surface-enhanced Raman scattering (SERS) applications in cancer diagnosis, We thus have developed a few strategies to engineer functional plasmonic nanomaterials for SERS-based in vitro cancer diagnostic applications.

Precision and Quantum Sensing Workshop / 31

Developing a Free-Space Quantum-Secure Time Transfer System

Author: Ben Sparkes[None]

Co-authors: Andre Luiten [1]; Fred Baynes [2]; James Quach [3]; Ken Grant [4]; Nicole Yuen [4]; Sabrina Slimani

[1] *The University of Adelaide, QuantX Labs*

[2] *QuantX Labs*

[3] *The University of Adelaide*

[4] *Defence Science and Technology Group*

We demonstrate quantum time transfer using correlated photons over a 100 m free-space link with picosecond resolution. We present our latest results showing the effects of loss and noise on our quantum clock synchronisation protocol.

AIP: Atomic and Molecular Physics / 32

New Opportunities in Fundamental Atomic Physics, Solid State Theory and Experiment and Synchrotron Science, including Discovery of new satellites using extended range High Energy Resolution Fluorescence Detection

Author: Christopher Chantler[1]

[1] *University of Melbourne*

High Energy Resolution Fluorescence Detection has recently developed as a powerful probe for bonding, nanostructure and oxidation state. We report the discovery of a new satellite in manganese using a new technique, XR-HERFD. This is foundational for many future studies.

AIP: Nuclear and Particle Physics / 33

New proposal for dark photon searches: parity-violating electron scattering

Author: Xuangong Wang[None]

Co-authors: Anthony Thomas [1]; Anthony Williams [1]

[1] *The University of Adelaide*

We propose that parity-violating electron scattering (PVES) provides promising opportunity for the dark photon searches. We explore the sensitivity of PVES asymmetry to the dark photon parameters. We also extract the favoured region by fitting the parity-violation data.

Poster session / 34

Nature of inertia and dynamic gravitational field

Author: Branko Kovac[None]

Presented is the concept of creating inertial force by the field theory. Provided is the candidate equation that describes inertial force by that field and the experiment that can test the new concept

Australian and New Zealand Conference on Optics and Photonics / 35

An Ultra-sensitive Fibre Frequency Reference for Short-term Laser Stabilisation

Author: Chathura Bandutunga[1]

Co-authors: Terry McRae [1]; Malcolm Gray [1]; Jong Chow [1]; Ya Zhang [1]

[1] *Australian National University*

We present an all-optical-fibre frequency reference with a state-of-the-art short-term stability of 0.1 $\mathrm{Hz}/\sqrt{\mathrm{Hz}}$, limited by double Rayleigh backscattering. The system also reaches the fibre thermal noise limit at infrasonic frequencies.

Australian and New Zealand Conference on Optics and Photonics / 36

Tunable Optical Metasurfaces with Amplitude and Phase Reconfigurability

Author: Dragomir Neshev[1]

[1] *Australian National University*

Optical metasurfaces are driving the future of miniaturised optical technologies for dynamically reconfigurable optics. Here, I will present our recent advances in reconfigurable optical metasurfaces, including liquid crystal-tunable metasurfaces for phase modulation and electrically-programmable thermo-optical metasurfaces for fast transmission modulation.

Australian and New Zealand Conference on Optics and Photonics / 37

Linear propagation of optical pulses with high-order dispersion

Author: Martijn De Sterke[1]

Co-authors: Antoine Runge [1]; Long Qiang [1]; Tristram Alexander [1]

[1] *University of Sydney*

We theoretically and numerically study the linear propagation of optical pulses in media with high-order dispersion m. We find that for high dispersion orders, all pulses follow a universal evolution depending only on m, eventually evolving to a sinc function.

Poster session / 38

Quantum entangled states of a classically radiating macroscopic spin

Author: Ori Somech[1]

Co-author: Ephraim Shahmoon

[1] *PhD student*

We introduce states that are the asymptotic eigenstates of the SU(2) lowering operator and are naturally produced in steady-state Dicke superradiance. A spin emitter in these states radiates classical-like coherent light, although these states are quantum entangled.

Conference on Optoelectronic and Microelectronic Materials and Devices / 39

Intrinsic quantum confinement and charge-carrier localisation in metal halide semiconductors

Author: Laura Herz[1]

[1] *University of Oxford*

Metal halide semiconductors have emerged as attractive materials for solar cells. In this talk I will discuss some of our recent work exploring the optoelectronic properties of lead-iodide perovskites and silver-bismuth halide semiconductors.

Poster session / 40

Compositionally Manipulating Nonlinearities in Novel Optical Fibers Based on the Molten Core Method

Author: Miranda Stone[None]

Co-authors: John Ballato [1]; Maxime Cavillon [2]; Peter Dragic [3]; Thomas W. Hawkins [1]

[1] *Clemson University*

[2] *University of Paris-Saclay*

[3] *University of Illinois*

Nonlinear properties of optical fibers are parasitic at high optical powers and can be manipulated by tuning the composition of the fiber core via the molten core method (MCM) for fiber fabrication.

Poster session / 41

Printable wafer-scale antimony-doped indium oxide nanosheets for high-performance optoelectronics

Author: Ms Nitu Syed[1]

[1] *The University of Melbourne*

Atomically thin antimony doped indium oxide nanosheets have been synthesized utilizing a scalable liquid metal-based printing technique. The work proposes a viable pathway for realizing ultrathin transparent semiconducting oxides with enhanced electronic and optical properties for next-generation optoelectronics.

Conference on Optoelectronic and Microelectronic Materials and Devices / 42

Liquid metal-assisted synthesis of atomically thin indium nitride films featuring 2D electron gases

Author: Ms Nitu Syed[1]

[1] *The University of Melbourne*

The work demonstrates the synthesis of ultrathin two-dimensional(2D) indium nitride(InN) films with few atom thicknesses and lateral dimensions exceeding centimeter-scale. The as-synthesized films feature 2D electron gases rendering them promising candidates for next-generation advanced optoelectronic devices and functional 2D heterostructures.

AIP: Condensed Matter, Materials and Surface Physics / 43

Optical Interaction of the NV– Centre in Diamond with a Plasmonic Metal Nanoparticle

Authors: Harini Hapuarachchi[1]; Francesco Campaioli[1]; Jared Cole[1]

[1] *RMIT University*

We demonstrate the possibility of significantly enhancing and precisely controlling the fluorescence of NV centres using plasmonic metal nanoparticles by developing the theoretical foundation for NV-plasmonic optical interaction (which is verified using existing optical measurements).

Poster session / 44

A Quantum Theory of Gravity

Author: Brian Robson[1]

[1] *Australian National University*

Gravity is determined, within the framework of the Generation Model of particle physics, to be a universal attractive finite-ranged residual interaction of the strong nuclear force, acting between the colourless constituents of ordinary matter.

Conference on Optoelectronic and Microelectronic Materials and Devices / 45

Semiconductor Nanowire THz Photonics

Author: Michael Johnston[1]

[1] *University of Oxford*

We have developed modulators and detectors of terahertz (THz) frequency radiation by exploiting the unique properties of semiconductor nanowires. Our new cross-nanowire THz receiver is enabling the emerging field of THz polarimetry.

Precision and Quantum Sensing Workshop / 46

Quantum microscopy with van der Waals heterostructures

Author: Jean-Philippe Tetienne[1]

Co-authors: Alex Healey [2]; Sam Scholten [2]; Tieshan Yang [3]; John Scott [3]; Gabriel Abrahams [2]; Islay Robertson [1]; Sharidya Rahman [4]; Yuerui Lu [4]; Mehran Kianinia [3]; Igor Aharonovich [3]

[1] *RMIT University*
[2] *University of Melbourne*
[3] *University of Technology Sydney*
[4] *Australian National University*

We demonstrate a microscopy technique that employs spin defects in hexagonal boron nitride as quantum sensors to perform magnetic and temperature imaging of van der Waals materials.

7th International Workshop on Speciality Optical Fibres / 47

Active Nanostructured Core Fiber for Two-Color Fiber Laser

Author: Ryszard Buczynski[None]

Co-authors: Marcin Franczyk [1]; Ivo Barton [2]; Dariusz Pysz [1]; Jaroslaw Cimek [1]; Ryszard Stepien [1]; Rafal Kasztelanic [1]; Mariusz Klimczak [3]; Luming Zhao [4]; Pavel Peterka [2]; Ivan Kasik [2]

[1] *Lukasiewicz Research Network - Institute of Microelectronics and Photonics*
[2] *Institute of Photonics and Electronics of the Czech Academy of Sciences*
[3] *University of Warsaw*
[4] *Huazhong University of Science and Technology*

We present the experimental study of active nanostructured fiber devoted to simultaneous laser emission at two wavelengths, 1040 nm and 1534 nm. The fiber core is formed with two types of nanorods doped with ytterbium and erbium ions.

Australian and New Zealand Conference on Optics and Photonics / 48

Spatial tomography of light resolved in time, spectrum and polarisation

Author: Martin Ploschner[1]

Co-authors: Marcos Morote ; Daniel Dahl ; Mickael Mounaix ; Greta Light ; Aleksandar Rakic ; Joel Carpenter

[1] *School of ITEE, The University of Queensland*

We harness principles of spatial state tomography to fully characterise an optical beam in space, time, spectrum, and polarisation. Analysis of the output of a vertical-cavity surface-emitting laser illustrates the technique's capabilities.

7th International Workshop on Speciality Optical Fibres / 49

An achromatic metafibre for focusing and imaging across the entire telecommunication range

Authors: Andreas Aigner[1]; Chenhao Li[2]; Haoran Ren[3]; Jaehyuck Jang[4]; Jisoo Kim[5]; Junsuk Rho[4]; Malte Plidschun[5]; Markus A. Schmidt[5]; Stefan A. Maier[3]

[1] *Ludwig-Maximilians-Universität München*

[2] *Ludwig-Maximilians-Universität München, München*

[3] *Monash University*

[4] *Pohang University of Science and Technology*

[5] *Leibniz Institute of Photonic Technology*

We fabricate a 3D achromatic diffractive metalens on the end face of a single-mode fiber, useful for endoscopic applications. We demonstrate achromatic and polarization-insensitive focusing across the entire near-infrared telecommunication wavelength band ranging from 1.25 to 1.65 μm.

AIP: Quantum Science and Technology / 50

No Tradeoff between Coherence and Sub-Poissonianity in Heisenberg-Limited Lasers

Author: Howard Wiseman[1]

Co-authors: Lucas Ostrowski [1]; Nariman Saadatmand ; Travis Baker [1]

[1] *Griffith University*

This work studies of families of laser models that exhibit both Heisenberg-limited beam coherence, and sub-Poissonian beam photon statistics. In particular, we investigate if imposing sub-Poissonian statistics comes at the expense of a reduction in the coherence.

Poster session / 51

X-ray spectroscopy of 3d transition metals

Author: Jonathan Dean[None]

Co-author: Christopher Chantler [1]

[1] *University of Melbourne*

Manganese characteristic X-ray spectra have been measured at the Diamond Light Source Synchrotron (U.K.) and compared with relativistic quantum theory.

AIP: Atomic and Molecular Physics / 52

Ab Initio Multiconfigurational Dirac-Hartree-Fock Characteristic X-Ray Spectra

Author: Christopher Chantler[1]

Co-authors: Hamish Melia ; Jonathan Dean

[1] *University of Melbourne*

Investigations in to satellite lines and diagram lines of complex open shell 3d transition metals. Specifically in scandium for this talk.

Poster session / 54

Subsystem criticality & bifurcating entanglement renormalization

Author: Dominic Williamson[None]

I will describe a bifurcating entanglement renomalization group flow that is based on the critical (1+ 1) D Ising model and go on to show that this defines a tensor network state with some unusual correlation function behaviour.

AIP: Atomic and Molecular Physics / 55

Testing atomic QED theory via a tuneout wavelength and transition measurements using a metastable helium Bose-Einstein condensate

Author: Sean Hodgman[None]

Co-authors: Bryce Henson ; Jacob Ross ; Kieran Thomas ; Carlos Kuhn ; David Shin ; Yong-Hui Zhang ; Li-Yan Tang ; Gordon Drake ; Aaron Bondy ; Danny Cocks ; Kenneth Baldwin ; Andrew Truscott

This presentation will cover a number of atomic energy level measurements involving ultracold metastable helium atoms, including using a tuneout wavelength to probe atomic QED theory.

AIP: Quantum Science and Technology / 56

Channel correction via heralded amplification

Author: Sergei Slussarenko[None]

We employ heralded amplification and quantum state teleportation to implement a channel capable that corrects for loss in quantum communication. Our channel genuinely outperforms direct transmission through high amount loss without relying on postselection.

Poster session / 58

On the evolution of nanoparticles in nanoparticle-doped optical fibers

Author: Mary Ann Cahoon[1]

Co-authors: Bailey Meehan [1]; Colin McMillen [1]; John Ballato [1]; Michel Digonnet [2]; Peter Dragic [2]; Thomas Hawkins [1]

[1] *Clemson University*

[2] *Stanford University*

This work studies the phase and structural evolution of Yb-doped alkaline earth fluoride nanoparticles in silica-based optical fiber during thermal treatments in fiber fabrication. This knowledge will aid in understanding and tailoring the optical properties in the resultant fibers.

Conference on Optoelectronic and Microelectronic Materials and Devices / 59

Engineering of Solid-State Random Lasing in Nanoporous Photonic Crystals

Authors: Abel Santos[None]; Cheryl Suwen Law[1]; Huong Nguyen Que Tran[1]; Juan Wang[1]; Khoa Nhu Tran[1]; Satyathiran Gunenthiran[1]; Siew Yee Lim[1]

[1] *The University of Adelaide*

Engineering of randome lasing in nanoporous photonic crystals

Conference on Optoelectronic and Microelectronic Materials and Devices / 60

Gold nanostars for sensitive molecular detection in biological fluids

Author: Anastasiia Tukova[None]

Co-authors: Yuling Wang ; Alfonso Garcia-Bennett ; Alison Rodger

Au-Ag nanostars, with enhanced plasmonic properties due to multiple “hot-spots” on the tips, stabilized in BSA@PBS buffer solution without formation of protein corona. The prepared nanostructures were stable in biological fluid and preserved their original enhanced optical activity.

Conference on Optoelectronic and Microelectronic Materials and Devices / 61

Nonvolatile Resistive Switching in Layered InSe via Electrochemical Cation Diffusion

Author: AISHANI MAZUMDER[None]

Non-volatile 2D memory systems are being widely considered because of their scalability. We experimentally and theoretically investigate 2D InSe for resistive switching alongside investigating the role of cations and anions in the switching mechanism.

Poster session / 62

Convergent close-coupling calculations of electrons scattering on HeH+

Author: Dmitry Fursa[1]

Co-authors: Bary Schneider [2]; Igor Bray [1]; Liam Scarlett [1]; Mark Zammit [3]

[1] *Curtin University*

[2] *NIST*

[3] *LANL*

The molecular convergent close-coupling (MCCC) method is used to perform calculations of 10–1000 eV electrons scattering on the electronic and vibrational ground state of HeH+. Cross sections are presented for excitation of the n=2–3 singlet and triplet states and ionization.

AIP: Quantum Science and Technology / 63

Comparison of Discrete and Continuous Variable Quantum Key Distribution Protocols over a Thermal-Loss Channel

Authors: Sebastian Kish[None]; Syed M. Assad[1]

Co-author: Ping Koy Lam [1]

[1] *ANU*

In a thermal-loss channel, it is uncertain whether a discrete-variable or a continuous-variable quantum key distribution (QKD) protocol is more optimal. We investigate QKD protocols in a thermal-loss setting but with the assumed availability of perfect sources and detectors.

Focus Session / 64

Programmable Metasurfaces by Electrically Driven Transparent Micro-Heaters

Author: Khosro Zangeneh Kamali[None]

Co-authors: Andrey Miroshnichenko ; Chennupati Jagadish [1]; Dragomir Neshev [2]; Hark Hoe Tan [3]; Lei Xu [4]; Mohsen Rahmani [4]; Nikita Gagrani [1]

[1] *ARC Centre of Excellence for Transformative Meta-Optical Systems (TMOS), Research School of Physics, The Australian National University, Canberra, ACT 2601, Australia*

[2] *Australian National University*

[3] *ARC Centre of Excellence for Transformative Meta-Optical Systems (TMOS), Research School of Physics, The Australian National University, Canberra, ACT 2601, Australia.*

[4] *Advanced Optics and Photonics Laboratory, Department of Engineering, School of Science and Technology, Nottingham Trent University, Nottingham NG11 8NS, United Kingdom*

We demonstrate for the first time the programmable tuning of dielectric inverse-designed metasurfaces made of silicon by electrically driven transparent micro-heaters. This approach made submillisecond switching time and individually tuning metasurfaces possible.

Poster session / **65**

Theoretical determination of Zinc Kα spectra using Multiconfigurational Dirac-Hartree-Fock Calculations

Authors: Christopher Chantler[1]; Hamish Melia[None]; Jonathan Dean[None]; Rosemary Zielinski[2]; Truong Nguyen[1]

[1] *University of Melbourne*

[2] *The Australian National University*

This work shows the relative success of using relativistic Hartree-Fock methods to theoretically predict characteristic x-ray spectra of zinc. We compare our results to experimental data, yielding promising fits.

7th International Workshop on Speciality Optical Fibres / **66**

Scalable All-Fiber Coherent Beam Combination Using Digital Control

Author: Samuel Legge[1]

[1] *Australian National University*

Demonstration of a polarisation maintaining all-fibre coherent beam combining system, digitally implemented using a FPGA and electro-optic modulators. The experimental implementation combines three 7 W Erbium-doped polarisation maintaining fibre amplifiers with greater than 95% efficiency and $\lambda/493$ RMS phase stability.

Poster session / **67**

The southern hemisphere's first X-band radio-frequency test facility at the University of Melbourne.

Author: Paarangat Pushkarna[None]

Co-authors: Geoffrey Taylor [1]; Matteo Volpi [2]; Roger Rassool [3]; Rohan Dowd [4]; Scott Williams [3]; Suzie Sheehy [5]

[1] *University of Melbourne*
[2] *University of Melbourne (AU)*
[3] *The University of Melbourne*
[4] *Australian Synchrotron - ANSTO*
[5] *University of Oxford and University of Melbourne*

The first Southern Hemisphere X-band Laboratory for Accelerators and Beams (X-LAB) is under construction at the University of Melbourne, it will form the basis for developing a compact accelerator for medical applications, such as radiotherapy and compact light sources.

Australian and New Zealand Conference on Optics and Photonics / 68

Miniature Zero-index Metamaterial based on Steiner Tree Topological Photonic Crystal

Authors: Haoyi Yu[1]; Min Gu[1]; Qiming Zhang[1]

[1] *University of Shanghai for Science and Technology*

We present a nano-engineered three-dimensional zero-index metamaterial based on Steiner tree networks as a novel topological photonic crystal, featuring a Dirac-like point and a photonic stop-gap to realize low-loss three-dimensional zero-index metamaterial at the wavelength around 1050 nm.

Conference on Optoelectronic and Microelectronic Materials and Devices / 69

Quantum sensing with boron nitride nanopowders

Author: Priya Singh[1]

Co-authors: Alex. J. Healey [2]; Fernando Meneses [2]; H Abe [3]; I. Aharonovich [4]; Islay. O. Robertson [1]; Jean-Philippe Tetienne [1]; M. Kianinia [4]; Philipp Reineck [1]; Roy Styles [1]; Sam. C. Scholten [2]; T Ohshima [3]

[1] *School of Science, RMIT University, Melbourne, VIC 3001, Australia*
[2] *School of Physics, University of Melbourne, VIC 3010, Australia*
[3] *National Institutes for Quantum Science and Technology (QST), 1233 Watanuki, Takasaki, Gunma 370-1292, Japan*
[4] *School of Mathematical and Physical Sciences, University of Technology Sydney, Ultimo, NSW 2007, Australia*

Validating the use of hexagonal boron nitride (hBN) nanopowders as a simple, cost-effective solution for quantum sensing applications. Demonstrating sensing of paramagnetic ions using hBN nanopowder and further exploring its magnetic sensing capabilities by preparing thin films of controlled thickness.

Australian and New Zealand Conference on Optics and Photonics / 70

Spatial reorganization of F-actin in respiratory cells as measured by Brillouin microscopy

Author: Irina Kabakova[1]

Co-authors: Hadi Mahmodi [1]; Peta Bradbury [2]; Aylin Cidem [2]; Hui Ong [3]; Daniela Traini [2]

[1] *University of Technology Sydney*

[2] *Respiratory Technology, Woolcock Institute of Medical Research, Glebe, Australia*

[3] *Macquarie Medical School, Faculty of Medicine, Health and Human Sciences, Macquarie University, Australia.*

Brillouin microscopy has emerged as a non-invasive and label-free technique to map micro-mechanical properties of cells. Here we apply Brillouin microscopy to probe reorganization of F-actin network in respiratory cells treated with Timothy grass pollen protein extracts.

Poster session / **71**

Monolithic Metalenses in Mono-Crystalline Silicon Carbide

Authors: Andrei Komar[1]; Dragomir Neshev[1]; Igor Aharonovich[2]; Johannes E. Fröch[2]; Mehran Kianinia[2]; Otto Schaeper[2]; Weibo Gao[3]; Zhao Mu[3]; Ziwei Yang[1]

[1] *Australian National University*

[2] *University of Technology Sydney*

[3] *Nanyang Technological University*

Our project demonstrates two types of monolithic SiC metalenses, a Conventional one and an extended focal length one, to capture light from quantum emitters embedded close to the surfaces of the monocrystalline SiC material.

Poster session / **72**

Chiral Electro-Optic Metasurfaces

Authors: Ilya Shadrivov[1]; Luyao Wang[None]

[1] *Australian National University*

We studied a direct and an inverse anisotropic structure made of Z-cut LN on the silica substrate, and evaluated the cross-polarisation conversion of linear incident polarisation and at tunable circular dichroism (CD) that can be achieved in these structures.

AIP: Group for Astroparticle Physics / Astronomy / **73**

Detection of the Sagittarius Dwarf Spheroidal Galaxy in Gamma-Rays

Author: Roland Crocker[None]

The search for gamma-ray emission from dwarf spheroidal galaxies is of ongoing interest in the context WIMP dark matter. We have detected a 1-100 GeV signal from the Sagittarius Dwarf Spheroidal, the third-most massive satellite of the Milky Way.

Conference on Optoelectronic and Microelectronic Materials and Devices / **76**

Enhanced Photodetection with BP – Organic Hybrid

Author: Mei Xian Low[1]

Co-authors: Dashen Dong [1]; Gregory Wilson [2]; Madhu Bhaskaran [1]; Michelle J. S. Spencer [1]; Patrick Taylor [1]; Prashant Sonar [3]; Qian Liu [4]; Sharath Sriram [1]; Sherif Abdulkader Tawfik [5]; Sruthi Kuriakose [6]; Sumeet Walia [1]; Taimur Ahmed [1]; Terry Chien-Jen Yang [7]

[1] *RMIT University*

[2] *CSIRO*

[3] *Queensland University of Technology*

[4] *Southern University of Science and Technology*

[5] *Deakin University*

[6] *Instituto de Ciencia de Materiales de Madrid*

[7] *University of Cambridge*

Tuning the charge transfer and optoelectronic properties of 2D materials such as black phosphorus (BP) by hybridising it with an organic semiconducting polymer.

AIP: Computational and Mathematical Physics / 77

BayesianNeural Networks for thePredictions of theProperties ofMillions of Novel 2-Dimensional Hetero-structures

Author: Marco Fronzi[1]

Co-authors: Alexander Corletto [2]; Amanda V. Ellis [2]; David A. Winkler [3]; Joseph Shapter [4]; Michael J. Ford [1]; Nick A. Shepelin [5]; Olexandr Isayev [6]; Peter C. Sherrell [2]

[1] *University of Technology Sydney*

[2] *University of Melbourne*

[3] *Monash University,*

[4] *The University of Queensland*

[5] *Paul Scherrer Institut*

[6] *Mellon University Pittsburgh*

Time and resource-efficient active machine learning approach has been used to create a database containing the functional and structural properties of millions of novel van der Waals layered structures.

Precision and Quantum Sensing Workshop / 78

Offset Decoding with A1 Sequences in Digitally Enhanced Interferometry

Authors: Anneshwa Dey[None]; Chathura Bandutunga[1]; Jong Chow[None]; Justin Wong[None]; Malcolm Gray[None]; Paul Sibley[None]; Ya Zhang[1]

[1] *Australian National University*

We present offset decoding in digitally enhanced interferometry using a a new pseudo random noise code called A1 code that leverages the benefits of traditionally used m-sequences and provides additional noise cancellation that enhances the phase fidelity of signal recovered.

Poster session / **79**

GPS from the ground up - a novel pedagogy for understanding general relativity

Author: Peter Huf[1]

Co-author: Matthew McPhail [2]

[1] *SYMMLAB*

[2] *Deakin University (student)*

In this paper we present a novel approach for learning relativity by combining theory (vectors, tensors) with electronic applications to the GPS system. The course is applicable as a practical introduction to the applied mathematics of relativistic theory and measurement.

Poster session / **80**

Exciton dynamics: Beyond thermal equilibrium

Author: Francesco Campaioli[None]

Exciton dynamics in organic semiconductors, such exciton transport and spin-mediated spectral conversion. Theoretical modelling and experimental interpretation using Markovian and non-Markovian quantum master equations. Dynamics, Steady-state solution and departure from Markovianity.

Poster session / **81**

Advanced Computational Relativistic Quantum Mechanics for the Investigation of Atomic Structures and Processes

Author: Truong Nguyen[1]

[1] *The University of Melbourne*

Discussion on our recent breakthroughs in theoretical atomic structural investigations using advanced relativistic quantum mechanics.

Conference on Optoelectronic and Microelectronic Materials and Devices / **82**

Structural investigation on epitaxially grown CdTe/Sb2Te3 materials

Author: Xiao Sun[1]

Co-authors: Wenwu Pan [2]; Songqing Zhang [2]; Renjie Gu [2]; Shuo Ma [2]; Wen Lei [2]

[1] *Curtin University*

[2] *The University of Western Australia*

In this work a 3D CdTe layer was grown on 2D Sb2Te3 nanosheets through molecular beam epitaxy, subsequently the heterostructure at the interface was studied by TEM, suggesting high quality epitaxial growth materials promising for applications in future optoelectronic devices.

Poster session / **83**

Taipan – a versatile thermal neutron scattering instrument for condensed matter and materials research

Author: Kirrily Rule[1]

Co-authors: Anton Stampfl [2]; Guochu Deng [2]

[1] *Australian Nuclear Science and Technology Organisation*

[2] *ANSTO*

Taipan is the highest flux, thermal neutron scattering instrument at ANSTO, Australia. This poster will present some recent scientific highlights at Taipan – both as a triple axis spectrometer, and a Be-filter analyser spectrometer.

AIP: Atomic and Molecular Physics / **85**

Antiproton collisions with excited positronium

Authors: Igor Bray[1]; Igor Bray[1]

[1] *Curtin University*

Calculation of antihydrogen formation via excited positronium (Ps(nl), $n \leq 7$) scattering on antiprotons is presented using the convergent close-coupling and classical trajectory Monte Carlo approaches. Though there are substantial disagreement for $n \leq 2$, we obtain good agreement for $n \geq 3$.

AIP: Biomedical and Medical Physics / **86**

Reducing Uncertainty in Proton Therapy Treatment Planning

Author: Melissa McIntyre[1]

Co-authors: Anthony Thomas [1]; Ayse Kizilersu [1]

[1] *University of Adelaide*

Proton therapy is a modern radiotherapy treatment which allows significant sparing of healthy tissues compared with conventional photon radiation. Some assumptions made during treatment planning introduce uncertainties into the process which should be well understood and quantified.

Australian and New Zealand Conference on Optics and Photonics / 87

A scalable, high-bandwidth warm atom quantum memory using hollow-core photonic crystal fibers

Author: Ben Sparkes[1]

Co-authors: Jed Rowland [2]; Josh Nunn [3]; Krzysztof Kaczmarek [4]; Rafal Gartman [3]; Andre Luiten [2]; Chris Perrella [2]

[1] *Defence Science and Technology Group*

[2] *University of Adelaide*

[3] *ORCA Computing Ltd*

[4] *ORCA Quantum Computing Ltd*

Using rubidium-filled hollow-core fibres we have reduced the optical power requirements of a no noise, high-bandwidth quantum memory protocol by two orders of magnitude, a key step towards a large-scale fibre-based quantum information network.

Precision and Quantum Sensing Workshop / 88

Underwater Operations of an Atomic Magnetometer for Magnetic Anomaly Detection

Author: Chris Perrella[1]

Co-authors: Ben Sparkes ; Kyle Netz ; Scott Foster ; Andre Luiten

[1] *University of Adelaide*

We present a deployable underwater atomic magnetometer that enables novel approaches to magnetic anomaly detection. We demonstrate that a pair of these magnetometers can detect a surface craft passing 15m above the submerged sensors.

AIP: Condensed Matter, Materials and Surface Physics / 89

The effect of pinholes on Josephson transport in AlOx tunnel junctions

Author: Karen Bayros[1]

Co-authors: Jackson Smith [1]; Jared Cole [1]; Martin Cyster [1]

[1] *RMIT University*

Josephson junctions are the key components of quantum computers based on superconducting qubits. We develop an atomistic model to study the effect of microscopic defects called “pinholes”, which could cause energy dissipation in Al/AlO_x/Al Josephson junctions.

AIP: Quantum Science and Technology / 90

A 4-Photon Entangled State for a Truly Reference-Frame-Independent Quantum Key Distribution Protocol

Author: Kareem Raslan[1]

Co-authors: James Quach [1]; Sabrina Slimani

[1] *The University of Adelaide*

We demonstrate a truly reference-frame-independent quantum key distribution protocol utilising a 4-photon entangled state. We present our latest results showing how local and global rotational invariance makes this protocol immune to a jamming attack.

Poster session / 91

Image and emission spectrum of luminescent nanostructures

Author: Lothar José Carlos Vilchis Martínez[1]

Co-authors: Elsi Violeta Mejía Uriarte [1]; Oleg Kolokoltsev [1]; Roberto Sato Berrú [1]

[1] *Universidad Nacional Autónoma de México*

In this work we obtain images using an Optical Laser Scanning system. Scanning is performed with a laser beam (375 nm) through a 100X microscope objective, the sample is in an XY translation stage (~ 20 nm by step).

AIP: Condensed Matter, Materials and Surface Physics / 92

Modelling transport properties of a transverse magnetic focusing system with spin-orbit coupling

Author: Yik Kheng Lee[None]

Co-authors: Jackson Smith [1]; Jared Cole [1]

[1] *RMIT University*

We use the finite difference method and the non-equilibrium Green’s function formalism to calculate transport properties of a two-dimensional transverse magnetic focusing system with spin-orbit coupling.

Conference on Optoelectronic and Microelectronic Materials and Devices / 93

Optically addressable spin defects in hexagonal Boron Nitride

Author: Mehran Kianinia[None]

Co-authors: Igor Aharonovich ; Milad Nonahal ; Simon White ; Thinh Tran

We demonstrate the controlled engineering of boron vacancy defects creation in two dimensional material hBN. The spin state in these defects can be controlled optically which is highly desirable for realization of quantum devices and scalable quantum communication technologies.

Poster session / 94

Cross sections for electron scattering from atomic tin

Author: Haadi Umer[1]

Co-authors: Dmitry Fursa [1]; Igor Bray [1]

[1] *Curtin University*

The relativistic convergent close-coupling method was applied to calculate a comprehensive collision dataset for electron scattering from atomic tin. Elastic, excitation and ionisation cross sections are presented for the ground and low-lying excited states.

Poster session / 95

Polarised Neutron Scattering Experiments at the Australian Centre for Neutron Scattering

Author: Andrew Manning[1]

[1] *ANSTO*

Neutron scattering is a powerful tool for investigating a variety of condensed-matter systems, and using spin-polarised neutrons reveals further unique information. The possibilities for performing scattering experiments with polarised neutrons at the Australian Centre for Neutron Scattering will be outlined.

Poster session / 96

Optimizing the Thermal characteristics of porous silicon thin films for thermal sensor application

Author: Sobhan Erfantalab[1]

[1] *School of Engineering, The University of Western Australia*

Here the thermal properties (thermal conductivity and heat capacity) of porous silicon thin films were experimentally investigated as a new material platform, for the realization of high speed and high sensitive thermal sensors.

Poster session / **97**

Hybrid dielectric/plasmonic approach to colour holograms encoded into colour printed images

Authors: Seyed Saleh Mousavi Khaleghi[1]; Dandan Wen[1]; Jasper Cadusch[1]; Kenneth Crozier[1]

[1] *Department of Electrical and Electronic Engineering, University of Melbourne, Victoria 3010, Australia*

We propose a hybrid dielectric/plasmonic approach for metasurfaces comprising colour holograms encoded into colour printed images. The metasurface employs plasmonic nanoholes in an aluminium film for colour filtering and amorphous titanium dioxide nanopillars for the phase control needed for holography.

Australian and New Zealand Conference on Optics and Photonics / **98**

Superresolution measurements and the quantum Gouy phase in transverse-spatial N00N states

Author: Markus Hiekkamäki[1]

Co-authors: Frédéric Bouchard [2]; Rafael F. Barros [1]; Marco Ornigotti [1]; Robert Fickler [1]

[1] *Tampere University*

[2] *National Research Council of Canada*

By structuring the spatial profile of single photons, we were able to demonstrate different types of quantum advantages in metrological applications. This method also enabled an investigation into a new type of quantum state evolution with possible future applications.

Precision and Quantum Sensing Workshop / **99**

Quantum diamond magnetometry for high pressure sensing

Authors: Antoine Hilberer[1]; Jean-Francois Roch[1]; Liam Hanlon[None]

Co-authors: Baptiste Vindolet [1]; Cassandra Dailledouze [2]; Dorothee Colson [3]; Florent Occelli [2]; Loic Toraille [2]; Marie-Pierre Adam [1]; Martin Schmidt [1]; Paul Loubeyre [2]; Thierry Debuisschert [4]

[1] *ENS Paris-Saclay*

[2] *CEA-DAM*

[3] *CNRS Paris-Saclay*

[4] *Thales research and Technology*

We use nitrogen-vacancy (NV) centers implanted directly into the culet of diamond anvil cells (DACs) in order to directly measure the magnetic field generated by samples at extremely high pressures. This allows for a direct study of high-pressure superconductivity.

Australian and New Zealand Conference on Optics and Photonics / **100**

Raman Spectroscopy detection of clinically significant prostate cancer: unraveling new trends within a clinical trial

Author: Suse J. van Breugel[1]

Co-authors: Claude Aguergaray [2]; Hannah U. Holtkamp [1]; Irene Low [3]; Kamran Zargar-Shoshtari [4]; M. Cather Simpson [1]; Mary L. Christie [3]; Michel K. Nieuwoudt [1]; Morgan R. Pokorny [3]; Ramya Nagarajan [3]

[1] *School of Chemical Sciences, The University of Auckland*

[2] *Department of Physics, The University of Auckland*

[3] *Counties Manukau District Health Board*

[4] *Faculty of Medical and Health Sciences, The University of Auckland*

A fibre-optic probe is applied to discriminate clinically significant cancers from non-significant & healthy prostate tissue using Raman Spectroscopy. Results show excellent classification between the two tissue types. Our current work aims to unravel new trends within our existing dataset.

AIP: Nuclear and Particle Physics / 101

GAMBIT update

Authors: Csaba Balazs[None]; The GAMBIT Community[None]

I give an update on the Global And Modular BSM Inference Tool and show the latest results for a model where the gravitino and the lightest neutralinos and charginos are the only light sparticles in the Minimal Supersymmetric Standard Model.

Poster session / 102

Evidence from CDF II and Muon g−2 for a new particle at 80.4287(22) GeV/c^2

Author: Robert Pfeifer[None]

Recent measurements of W mass and muon gyromagnetic anomaly disagree with the Standard Model. Both are reconciled by a preon model, with tension under 0.5 sigma and first-principles prediction of W and Z masses.

AIP: Atomic and Molecular Physics / 103

Modeling of electron interactions in the Earth's mesosphere

Author: Laurence Campbell[1]

Co-author: Michael Brunger [1]

[1] *Flinders University*

A method for computational modeling of electron interactions in gases is applied to processes in the Earth's mesosphere. Electrons in different subranges of energy are treated in the same way as species in chemical models.

Australian and New Zealand Conference on Optics and Photonics / 104

Terahertz waveguides: the fundamental component for next generation of communication

Author: Shaghik Atakaramians[None]

There is a rapid development in utilizing Terahertz frequencies for next generation of communications. In this talk, I will discuss how recent advances in photonics can facilitate low-loss and low-dispersion waveguides with exceptional bandwidth for terahertz.

Precision and Quantum Sensing Workshop / 105

Polarization dependent quantum correlation measurements of two nitrogen-vacancy color centres in diamond

Author: Davin Yue Ming Peng[1]

Co-authors: Andrew D. Greentree [1]; Brant C. Gibson [1]; Josef G. Worboys [1]; Marco Capelli [1]; Philipp Reineck [1]; Qiang Sun [1]

[1] *Australian Research Council Centre of Excellence for Nanoscale Biophotonics, RMIT University*

By focusing on the second-order correlation as a function of emission polarization, we demonstrate additional information gained from using polarization combined correlation optics and pave the way for future protocols in sub-diffraction limited particle localization and characterization via quantum imaging.

Poster session / 106

Real time monitoring of nitrogen vacancy fluorescence during ultrafast pulsed laser heating of diamond

Author: Davin Yue Ming Peng[1]

Co-authors: Andrew D. Greentree [1]; Benjamin P. Cumming [2]; Brant C. Gibson [1]; Marco Capelli [1]; Philipp Reineck [3]; Qiang Sun

[1] *Australian Research Council Centre of Excellence for Nanoscale Biophotonics, RMIT University*

[2] *RMIT University*

[3] *School of Science, RMIT University, Melbourne, VIC 3001, Australia*

Here we report the research of real-time fluorescence monitoring during the creation of NV color centers in diamond using a femtosecond laser.

AIP: Theoretical and Mathematical / 107

Quantum Central Limit Theorems, Emergence of Classicality and Time-dependent Differential Entropy

Author: Tien Kieu[1]

[1] *Centre for Quantum Technology Theory and Optical Sciences Centre, Swinburne University of Technology, Victoria, Australia*

We derive some Quantum Central Limit Theorems for expectation values of coarse-grained observables, as functions of hermitean operators of non-commuting variables. These open some pathway for an emergence of classical behaviours. We also obtain some nontrivial time-dependent differential entropies.

7th International Workshop on Speciality Optical Fibres / 109

Mid-Infrared Polarization-Maintaining Photonic Crystal Fiber

Author: FRANCOIS CHENARD[None]

Co-authors: Erik Schartner [1]; Oseas Alvarez [2]; Anna Radionova [1]; Heike Ebendorff-Heidepriem [1]

[1] *Institute for Photonics and Advanced Sensing (IPAS) & School of Physical Sciences, The University of Adelaide, Adelaide 5005, SA, Australia*

[2] *IRflex Corporation*

A solid-core endlessly single mode mid-infrared polarization-maintaining photonic crystal fiber (PM-PCF) made of chalcogenide glass with an asymmetric pattern of longitudinal holes having different periods and diameters is presented. Simulation and experimental results are given.

Poster session / 110

Enhancement in NELIBS with silver and gold nanoparticles and N-Graphene QDs

Author: Carlos Eduardo Nogales Herrera[1]

Co-authors: César Costa-Vera [1]; Isamar Sarabia [1]

[1] *Escuela Politécnica Nacional*

Gold and Silver Nanoparticles and N-Graphene Quantum Dots (N-GQDs) were used for NELIBS. 199% and 208% of signal improvements were reached with Au and Ag nanoparticles. In N-GQDs case, 79% of signal improvement was reached.

Poster session / 113

LNOI ring resonators for synthetic frequency dimension photonics

Author: Xuan Hiep Dinh[1]

Co-authors: Thach Nguyen [1]; Armandas Balcytis [1]; Tomoki Ozawa [2]; Toshihiko Baba [3]; Yasutomo Ota [4]; Satoshi Iwamoto [5]; Arnan Mitchell [1]

[1] *Integrated Photonics and Applications Centre, RMIT University, Melbourne, VIC 3000, Australia*

[2] *Advanced Institute for Materials Research, Tohoku University, Sendai 980-8577, Japan*

[3] *Department of Electrical and Computer Engineering, Yokohama National University, Yokohama 240-8501, Japan*

[4] *Department of Applied Physics and Physico-Informatics, Keio University, Yokohama 223-8522, Japan*

[5] *Research Center for Advanced Science and Technology, The University of Tokyo, Tokyo 153-8904, Japan*

An integrated lithium niobate on insulator ring resonator photonic device with efficient high-speed modulators hosts a synthetic frequency dimension lattice, revealed by characterizing its steady-state performance and real-time acquisition of its tight-binding model band structures.

AIP: Nuclear and Particle Physics / 116

Testing the Quark Model on the Delta Baryon Spectrum

Author: Liam Hockley[1]

Co-authors: Anthony Thomas ; Curtis Abell [2]; Derek Leinweber [3]; Waseem Kamleh [2]

[1] *The University of Adelaide*

[2] *University of Adelaide*

[3] *CSSM, University of Adelaide*

We present studies of the Δ baryon spectrum using lattice QCD and Hamiltonian Effective Field Theory. Our results suggest quark model-like states and meson-baryon two-particle states both contribute to the energy spectrum observed in experiment.

AIP: Biomedical and Medical Physics / 118

Modelling the effect of daughter migration on dosimetry estimates for Actinium-225 in Targeted Alpha Therapy

Authors: Stephen Tronchin[1]; Jake Forster[2]; Kevin Hickson[3]; Eva Bezak[4]

[1] *Department of Physics, University of Adelaide, Adelaide SA 5005, Australia.*

[2] *Department of Physics, University of Adelaide, Adelaide SA 5005, Australia. | Medical Physics & Radiation Safety, South Australia Medical Imaging, Adelaide SA 5000, Australia.*

[3] *Medical Physics & Radiation Safety, South Australia Medical Imaging, Adelaide SA 5000, Australia. | Allied Health & Human Performance, University of South Australia, Adelaide SA 5001, Australia.*

[4] *Department of Physics, University of Adelaide, Adelaide SA 5005, Australia. | Cancer Research Institute, University of South Australia, Adelaide SA 5001, Australia.*

We developed a compartment model where we assigned each daughter of actinium-225 unique biokinetics. We used the model to study the effect of daughter migration on organ doses in Targeted Alpha Therapy.

Australian and New Zealand Conference on Optics and Photonics / 119

On-chip chalcogenide glass resonators and waveguides for mid-infrared applications

Author: Hansuek Lee[1]

[1] *Korea Advanced Institute of Science and Technology*

Recently, a method to form light-guiding geometries on a chip by depositing a core material without a following etching process has been developed and verified with chalcogenide glass. We introduce the current results showing extremely low loss and their applications.

AIP: Atomic and Molecular Physics / 120

Ultradilute Quantum Droplets

Author: Xia-Ji Liu[1]

[1] *Swinburne University of Technology*

Ultradilute Quantum Droplets

Conference on Optoelectronic and Microelectronic Materials and Devices / 121

Time-resolved photoionization detection of a single Er3+ ion in silicon

Author: Gabriele de Boo[1]

Co-authors: Brett Johnson [2]; Chunming Yin [3]; Guangchong Hu [1]; Jeff McCallum [4]; Matthew Sellars [5]; Sven Rogge [1]

[1] *UNSW Sydney*

[2] *RMIT*

[3] *USTC*

[4] *University of Melbourne*

[5] *ANU*

We investigate the charge dynamics following the optical excitation of a single erbium ion inside a silicon FinFET. We observe a latched charge signal that depends on gate voltage, optical intensity and optical pulse length.

Conference on Optoelectronic and Microelectronic Materials and Devices / 122

Scalable multilayer epitaxial lift-off for III-V photovoltaics and optoelectronic devices

Author: Tuomas Haggren[1]

Co-authors: Chennupati Jagadish [2]; Hark Hoe Tan [3]; Jani Oksanen [4]; Julie Tournet [5]

[1] *ARC Centre of Excellence for Transformative Meta-Optical Systems (TMOS), Research School of Physics, The Australian National University, Canberra, ACT 2601, Australia*

[2] *ARC Centre of Excellence for Transformative Meta-Optical Systems (TMOS), Research School of Physics, The Australian National University, Canberra, ACT 2601, Australia*

[3] *ARC Centre of Excellence for Transformative Meta-Optical Systems (TMOS), Research School of Physics, The Australian National University, Canberra, ACT 2601, Australia.*

[4] *Engineered Nanosystems group, Department of Neuroscience and Biomedical Engineering, School of Science, Aalto University*

[5] *The Australian National University*

We present a multilayer epitaxial lift-off process for thin-film fabrication for photovoltaics, flexible optoelectronics and III-V metamaterials. The lift-off process provides significant cost benefits by lifting off multiple large-area films from a single epitaxial stack.

Australian and New Zealand Conference on Optics and Photonics / 123

Characterising Solitons with Tuneable Multi-peak Spectra

Authors: Justin Widjaja[1]; Martijn De Sterke[1]

[1] *University of Sydney*

We numerically and analytically examine solitons arising from a dispersion relation with several peaks of different local curvatures and wavenumbers. Their spectra have multiple separate frequency components whose relative intensities depend on the pulse power.

Poster session / 124

Storing the sunshine: outer valence ionization potentials of norbornadiene and quadricyclane

Author: Feng Wang[1]

[1] *Swinburne University of technology*

The study theoretically investigates outer valence molecular orbitals in the isomerization of of norbornadiene and quadricyclane. Through space interaction of NBD is confirmed as the next highest occupied molecular orbital (10a1) of NDB.

Poster session / 125

Sensitive temperature-dependent spin properties in hBN nanopowders

Author: Fernando Meneses[1]

Co-authors: Alexander Healey [1]; Islay Robertson [2]; Jean-Philippe Tetienne [2]; Lloyd Hollenberg ; Priya Singh [2]; Sam Scholten [1]

[1] *The University of Melbourne*

[2] *RMIT University*

This study analyses the temperature-dependent spin and optical properties of hexagonal boron nitride (hBN) nanopowders, which show a complex profile in optically detected magnetic resonance (ODMR) that may be exploited as a sensitive temperature sensor.

Poster session / **126**

Discrete-variable Wigner function formalisms and the Weyl-Heisenberg displacements

Author: Lucky Antonopoulos[1]

Co-author: Nicholas Menicucci [1]

[1] *Centre for Quantum Computation and Communication Technology, School of Science, RMIT University, Melbourne, VIC 3000, Australia*

In this work, we look at three different discrete-variable Wigner functions corresponding to single Weyl-Heisenberg displacements and compare them. What we find that is that these functions are equivalent up to some non-trivial phase dependent on the displacement amount.

AIP: Nuclear and Particle Physics / **127**

Using TDHF simulations of quasifission to probe the fission surface of Og-294

Author: Patrick McGlynn[None]

Co-author: Cedric Simenel

Shell effects in nuclear fission of superheavy oganesson-294 are investigated through simulations of quasifission trajectories. Results show that shell effects from fission affect quasifission along with excitation energy dependent changes.

AIP: Atomic and Molecular Physics / **128**

Phase retrieval by angular streaking of XUV atomic ionization

Author: Anatoli Kheifets[1]

[1] *Australian National University*

We demonstrate an accurate phase retrieval of XUV atomic ionization by streaking photoelectrons in a circularly polarized IR laser field. This novel technique will be instrumental for studying inner shell atomic and molecular ionization using free-electron lasers.

AIP: Nuclear and Particle Physics / **129**

Measurement of the branching fraction and CP asymmetry of $B^0 \to \pi^0\pi^0$ decays

Author: Francis Pham[None]

Co-author: Martin Sevior

We report branching fraction and CP asymmetry measurements of the $B^0 \to \pi^0\pi^0$ decay mode at Belle II using a data sample corresponding to $198 \times 10^6 B\bar{B}$ pairs. This is comparable sensitivity with 1/4th of the Belle dataset.

7th International Workshop on Speciality Optical Fibres / 130

200 km-long single-ended random fiber laser and sensor with ULLF

Author: Yunjiang Rao[1]

Co-authors: Bing Han [1]; Han Wu [2]; Jiangming Xu [1]; Lingmei Ma [3]; Shisheng Dong [1]; Yang Liu [1]; Zinan Wang [1]

[1] *UESTC*

[2] *Sichuan University*

[3] *Zhejiang Laboratory*

Record-long (200 km) single-ended random fiber laser and sensor, which can be used for safety monitoring of long-haul powerlines, are proposed and demonstrated based on combination of high-order random lasing pump and ultra-low-loss fiber, for the first time.

Precision and Quantum Sensing Workshop / 131

Measuring fundamental thermal phase fluctuations in a passive fibre resonator

Author: Jonathan Hedger[None]

Co-authors: Andre Luiten [1]; Ashby Hilton [2]; Ben Sparkes [3]; Martin Becker [4]; Nicolas Bourbeau Hebert [2]; Scott Foster [5]; Tino Elsmann [4]

[1] *The University of Adelaide, QuantX Labs*

[2] *University of Adelaide*

[3] *Defence Science and Technology Group*

[4] *IPHT*

[5] *DSTG*

We measure strain at the thermodynamic limit in custom passive optical fibre resonators to verify theoretical predictions that govern fundamental interactions between entropy fluctuations and a fibre sensor.

Australian and New Zealand Conference on Optics and Photonics / 132

Metasurface sorting of Orbital Angular Momentum Modes

Author: judith dawes[1]

[1] *Macquarie university*

Orbital angular momentum modes of light offer excellent prospects for increased bandwidth for spatial division multiplexing for communications with minimal cross talk. Here we discuss the application of metasurfaces to analyse orbital angular momentum modes in free space.

AIP: Quantum Science and Technology / 133

Streamlined quantum computing with equivalent gate noise on macronode cluster state architectures

Authors: Ben Baragiola[1]; Blayney Walshe[1]; Nicolas Menicucci[1]; Rafael Alexander[1]

[1] *Centre for Quantum Computation and Communication Technology, School of Science, RMIT University, Melbourne, VIC 3000, Australia*

Cluster states in continuous-variable quantum computing come in various configurations. The authors demonstrated a significant drop in the required quality of a particular configuration. Here, we also present those improvements in other configurations.

Poster session / 134

A New Approach to Low-Mass Dark Matter Detection

Authors: Glen Harris[1]; Peter Cox[2]; Matthew Dolan[3]; Maxim Goryachev[4]; Christopher Baker[1]; Warwick Bowen[5]

[1] *University of Queensland*

[2] *The University of Melbourne*

[3] *University of Melbourne*

[4] *University of Western Australia*

[5] *The University of Queensland*

Ultra-low mass WIMP's are viable dark matter candidates. However, the resulting low-energy excitations are extraordinarily difficult to detect. I will outline a new experimental platform that translates the capabilities of optomechanics to enable detection of ~1ueV excitations in superfluid helium.

AIP: Education / 136

Our Experience with Pass/Fail Grading in First Year Physics

Author: Elizabeth Angstmann[None]

Co-author: Kate Jackson [1]

[1] *UNSW*

Our talk will discuss our experience so far with pass/fail grading and research we intend to conduct over the next year.

Poster session / **137**

Optical lock-in camera for gravitational wave detectors

Authors: Daniel Brown[1]; David Ottaway[1]; Huy Tuong Cao[1]; Mitchell Schiworski[2]; Peter Veitch[1]

[1] *University of Adelaide*

[2] *University of Adelaide, Australia*

Phase cameras are wavefront sensors which measure the transverse amplitude and phase of specific frequency components of optical fields. In this presentation we discuss a new all optical phase camera design and give an overview of previous and ongoing applications.

Poster session / **138**

State-Selective Electron Capture in Ne^{10+} + H(1s) Collisions

Author: Aks Kotian[1]

Co-authors: Corey Plowman [1]; Ilkhom Abdurakhmanov [2]; Igor Bray [1]; Alisher Kadyrov [1]

[1] *Curtin University*

[2] *Pawsey Supercomputing Centre*

We study electron capture and ionisation in fully-stripped neon ion collisions with ground-state atomic hydrogen using the two-centre wave-packet convergent close-coupling (WP-CCC) method over the energy range from 1 keV/u to 2 MeV/u.

AIP: Atomic and Molecular Physics / **139**

Coupled-Channel Approach to Proton Scattering on Molecular Hydrogen Using an Effective One-Electron Model

Author: Corey Plowman[None]

Co-authors: Alisher Kadyrov [1]; Igor Bray [1]; Ilkhom Abdurakhmanov [2]

[1] *Curtin University*

[2] *Pawsey Supercomputing Centre*

Total cross sections for all single-electron processes in proton scattering on molecular hydrogen have been calculated within a two-centre coupled-channel approach, providing improved agreement between theory and experiment for this challenging collisional system.

AIP: Nuclear and Particle Physics / **141**

Ways of seeing: maximising the discovery potential of the Large Hadron Collider

Author: Martin John White[1]

[1] *University of Adelaide (AU)*

I will show the sorts of physics model that are currently evading detection at the Large Hadron Collider, and will present new ideas for how to extend the reach of particle searches with the ATLAS and CMS detectors.

Poster session / **142**

A Machine Learning Chemical Classifier using a Bound-State-in-the-Continuum Dielectric Metasurface Filter Array

Author: Benjamin Russell[None]

Co-authors: Jiajun Meng ; Kenneth Crozier

We have simulated a microspectrometer system that utilises a BIC transmission filter array with a photodetector array and have used it to identify common acyclic hydrocarbons down to 50 ppm concentrations via a machine learning classifier.

Poster session / **143**

Monte Carlo modelling of elastic and Raman returns from the water column

Authors: Brad Neimann[1]; David Spence[None]; Helen Pask[1]

[1] *Macquarie University*

We present the first, to our knowledge, Monte Carlo model of Raman scattering in the water column under pulsed laser excitation, and will compare and contrast the characteristics of elastic and Raman returns.

Australian and New Zealand Conference on Optics and Photonics / **144**

Wearable Optical Fibre Sensors for Physiological Measurements

Author: Simon Fleming[None]

Co-authors: Alessio Stefani [1]; Antoine Runge [2]; Ivan Rukhlenko [1]; Maryanne Large [1]

[1] *The University of Sydney*

[2] *University of Sydney*

We report on a polyurethane capillary fiber sensor that transduces body movements containing information of physiological parameters such as respiratory and pulse rates. We also investigate key factors, like transfer function, for successful system design.

AIP: Quantum Science and Technology / **145**

Conceptual understanding enabled by efficient automated design of quantum optical setups

Author: Nora Tischler[1]

Co-authors: Alan Aspuru-Guzik [2]; Jakob Kottmann [2]; Mario Krenn [3]

[1] *Centre for Quantum Dynamics, Griffith University, Brisbane, Australia*

[2] *Departments of Chemistry and Computer Science, University of Toronto, Toronto, Ontario M5S 3H6, Canada*

[3] *Max Planck Institute for the Science of Light, Erlangen 91058, Germany*

Artificial intelligence is a powerful tool for science, but an important question is how to extract true scientific understanding. We present a method that enables new understanding, and demonstrate its application to quantum photonics.

Poster session / 146

Microdiamond-Silk Wound Dressings for Early Infection Intervention through Temperature Sensing

Author: Ethan JG Ellul[1]

Co-authors: Allison J Cowin [2]; Amanda N Abraham [3]; Asma Khalid [3]; Brant C Gibson [3]; Gabriel Abrahams [3]; Hanif Haidari [2]; Hinoshi Abe [4]; Islay Robertson [3]; Jean-Philippe Tetienne [3]; Laura Hung [3]; Shadi Houshyar [5]; Takeshi Ohshima [4]; Zlatko Kopecki [2]

[1] *RMIT University*

[2] *Future Industries Institute, University of South Australia, Adelaide, SA 5000, Australia*

[3] *ARC Centre of Excellence for Nanoscale Biophotonics, School of Science, RMIT University, Melbourne, Victoria 3000, Australia*

[4] *National Institute for Quantum and Radiological Science and Technology, Takasaki, Japan*

[5] *School of Engineering, RMIT University, Melbourne, Victoria 3000, Australia*

A transparent smart wound dressing has been developed using Nitrogen Vacancy Centre Microdiamonds within a silk film for temperature detection, enabling early intervention of surface infections for acute wounds.

Conference on Optoelectronic and Microelectronic Materials and Devices / 147

Quantum Confinement of Donor Molecule Systems in Silicon

Author: A M Saffat-Ee Huq[1]

Co-authors: Yu-Ling Hsueh [1]; Michelle Simmons [1]; Rajib Rahman [1]

[1] *The University of New South Wales*

Applying a comprehensive 20-band $sp^3d^5s^*$ tight-binding model with self-consistent field Hartree method to calculate energies of multi-electron states, we investigate the D^- charging energies of donor molecules in silicon consisting of two phosphorus impurities in various orientations.

Australian and New Zealand Conference on Optics and Photonics / 148

Levitodynamics with optically active nanocrystals

Author: Cyril Laplane[None]

We present our investigations into the dynamics of levitated rare-earth ions doped nanocrystals using optical tweezers. In particular we will present results on the absolute cooling (i.e. of the motional and internal temperature) of these levitated nanocrystals.

AIP: Quantum Science and Technology / 149

Achieving the ultimate end-to-end rates of lossy quantum communication networks

Author: Matthew Winnel[None]

Co-authors: Joshua Guanzon ; Nedasadat Hosseinidehaj ; Timothy Ralph

The highest rates of quantum communication networks are fundamentally limited by the transmission distance between quantum repeaters. In this work, we give a practical design for this achievability.

AIP: Relativity and Gravitation / 151

Continuous Gravitational Waves from Young Neutron Stars

Author: Ben Grace[None]

This talk focuses on work completed in adapting continuous gravitational wave search techniques, currently only sensitive to long lived stable neutron stars, to be suited to detecting young neutron stars with rapidly changing frequency.

Conference on Optoelectronic and Microelectronic Materials and Devices / 152

Measurement driven quantum clock implemented with a superconducting qubit

Author: Xin HE[None]

Co-authors: Adil Gangat ; Arkady Fedorov ; Gerard Milburn ; Prasanna Pakkiam

We theoretically and experimentally demonstrate a quantum clock implemented with a superconducting qubit and show the thermodynamic limit of the clock accuracy in the quantum regime is caused by the entropy production rate.

AIP: Group for Astroparticle Physics / Astronomy / 153

Enhancing gravitational-wave burst detection confidence in expanded detector networks with the BayesWave pipeline

Authors: Andrew Melatos[1]; Margaret Millhouse[1]; Yi Shuen Christine Lee[1]

[1] *The University of Melbourne and ARC Centre of Excellence for Gravitational Wave Discovery (OzGrav)*

We discuss the impact of adding more detectors on gravitational-wave burst detection confidence, using the BayesWave algorithm: a source-agnostic Bayesian analysis pipeline. BayesWave reconstructs non-Gaussian transient features in detector data for the characterisation of astrophysical signals and instrumental glitches.

Focus Session / 154

Particle and Nuclear Physics at the MeV scale in Australia

Author: Martin Sevior[None]

Co-authors: Andrea Thamm [1]; Andrew Stuchbery [2]; David Jamieson [1]; Lindsey Bignell [2]; Tibor Kibédi [2]

[1] *University of Melbourne*

[2] *The Australian National University*

We propose a Time Projection Chamber (TPC) to measure (e+e-) production from proton induced nuclear reactions. TPC measurements provide 200 times more sensitivity than previous experiments enabling world-leading limits for New Physics searches and novel Nuclear Physics investigations.

7th International Workshop on Speciality Optical Fibres / 155

Comparison of Radiation-Induced-Attenuation in Pure Silica Core and F-doped Silica fibres

Author: Garry Berkovic[None]

file attached

Poster session / 156

Benchmarking of Different Optimizers in the Variational Quantum Algorithms for Applications in Quantum Chemistry

Author: Harshdeep Singh[1]

Co-authors: Sabyashachi Mishra [1]; Sonjoy Majumder [1]

[1] *IIT Kharagpur*

This work focuses on the performance of different classical optimizers when used in variational quantum algorithms, specifically for applications in quantum chemistry, for example, evaluating the ground state energy, the dissociation energy, and the dipole moment of different molecules.

AIP: Relativity and Gravitation / 157

Space-Time Inside a Star

Authors: Ejov Vlad[1]; Samuel Drake[1]; Yang Shi[1]

[1] *Flinders University*

Exact solutions to Einstein's field equations are notoriously difficult. In this work we obtain expressions for the metric tensor for the interior of a star, i.e., for static spherically symmetric space-times with positive and monotonically decreasing density and pressure.

Poster session / 158

Quantum Machine Learning: Quantum Kernel Methods

Author: Sanjeev Naguleswaran[None]

Quantum Machine Learning is an exciting prospect emerging from the recent advances in Quantum Computing. The ability to derive a quantum advantage over classical algorithms is paramount and this paper explores methods based on quantum kernels to realise this advantage.

Australian and New Zealand Conference on Optics and Photonics / 159

Development of a Fast-Scanning LiDAR System with High Spatial Resolution

Author: Liam Sutton[1]

Co-authors: Craig Wheeler [1]; Dusan IIic [1]; John Holdsworth [2]; Kenneth Williams [1]

[1] *University of Newcastle*

[2] *ANZOS*

A high spatial resolution, fast-scanning LiDAR has been developed for dust plume detection. A UV laser source, photomultiplier detection, fast DAQ electronics, IMU and GPS location were assembled on a 355mm Dobsonian telescope for off-grid detection of mining dust plumes.

Poster session / 160

Non-linear simulations of weak gravitational lensing

Author: Adam Stewart[1]

Co-author: Jan Hamann [1]

[1] *The University of New South Wales*

We perform fully non-linear simulations of cosmological weak gravitational lensing and extract observables that will be probed by the next generation of large scale structure surveys.

Australian and New Zealand Conference on Optics and Photonics / 161

Optimisation of a Fibre Laser Hydrophone for Marine Traffic Monitoring

Author: Alexei Tikhomirov[1]

Co-authors: Bradyn Gray [1]; Nikita Simakov [1]; Shanae Lay [1]

[1] *DSTG*

Refinement and adaptation of the distributed feedback fiber laser based hydrophone for the remote monitoring of marine traffic is reported. Hydrophone bandwidth and multiplexing noise have been mitigated; a substantial increase in hydrostatic pressure compensation depth has been demonstrated.

AIP: Quantum Science and Technology / 164

Quantum-Enhanced Agents: Can Quantum Machines Better Adapt to Complex Environments?

Author: Mile Gu[1]

Co-authors: Andrew Garner [2]; Jayne Thompson [3]; Keith Ng [1]; Paul Riechers [1]; Thomas Elliott [4]

[1] *Nanyang Technological University*

[2] *Institute for Quantum Optics and Quantum Information*

[3] *Horizon Quantum Computing*

[4] *Imperial College London*

Talk based on a combination of Phys. Rev. X 12, 011007 and unpublished work.

AIP: Atomic and Molecular Physics / 165

The exact properties of ultracold polarons

Author: Jia Wang[1]

Co-authors: Hui Hu [1]; Xia-Ji Liu [1]

[1] *Swinburne University of Technology*

We investigate the nonlinear response of heavy impurity in ultracold Fermi gases and superfluid with a numerically exact approach. Our results are highly relevant for polaron physics.

Australian and New Zealand Conference on Optics and Photonics / 166

Photoswitching upconversion emission with high-energy irradiation

Author: Simone Lamon[1]

Co-authors: Weizhao Gu [1]; Qiming Zhang [1]; Min Gu [1]

[1] *University Of Shanghai For Science And Technology*

The photoswitching of upconversion nanoparticles was shown under high-energy irradiation. Time-dependent upconversion emission changes were ascribed to lanthanide ion valence state shifts. These findings offer new avenues for optical switching enabled by upconversion nanoparticles.

Australian and New Zealand Conference on Optics and Photonics / 167

Exploring higher order dispersion: Families of exact soliton solutions

Author: Yun Long Qiang[None]

Co-authors: Martijn De Sterke [1]; Tristram Alexander [1]

[1] *University of Sydney*

Recent studies have shown that solitons dominated by higher order dispersion effects give rise to a large family of possible soliton solutions. We study soliton solutions formed in higher order dispersion systems and uncover families of exact analytic solutions.

AIP: Atomic and Molecular Physics / 168

Second sound with ultracold atoms

Author: Hui Hu[None]

We briefly review the research on second sound in ultracold atomic physics, with emphasis on strongly interacting unitary Fermi gases with infinitely large s-wave scattering length.

Focus Session / 169

Real-time phase imaging via nanophotonic devices

Author: Lukas Wesemann[1]

Co-authors: Jon Rickett [1]; Jingchao Song [2]; Jieqiong Lou [2]; Elizabeth Hinde [2]; Timothy J. Davis [1]; Ann Roberts [1]

[1] *University of Melbourne, ARC Centre of Excellence for Transformative Meta-Optical Systems*

[2] *University of Melbourne*

Nanophotonic devices enable image processing with potential for biological live-cell imaging and wavefront sensing. Here we demonstrate the use metasurfaces and thin-films for all-optical visualisation of phase modulations in an optical field and their application to biological imaging.

AIP: Relativity and Gravitation / 170

The latest development in ALFRA, the UWA low-frequency rotational accelerometer

Author: Carl Blair[1]

Co-authors: Chunnong Zhao [1]; Li Ju [1]; John Winterflood [1]; Jack Williamson [1]; Ammar Al-Jodah [1]

[1] *University of Western Australia*

In this talk, we will present our latest developments of the advanced low-frequency rotational accelerometer that has direct utilization in seismology applications and seismic isolation in gravitation wave detectors.

Poster session / **172**

Prolonging memory retention in optoelectronics devices using compensation model

Author: Thiha Aung[None]

Weights in the convolutional neural network are stored as memory in optoelectronic devices. The performance of the neural network drops in a few milliseconds. We use a model to prolong the memory to several minutes.

Conference on Optoelectronic and Microelectronic Materials and Devices / **173**

Solid-state Nanopore: A Nanoelectronic Sensor for Single-Molecule Diagnostics

Author: Buddini Karawdeniya[1]

Co-authors: Shankar Dutt [1]; Y.M. Nuwan Bandara [1]; Aarti Gautam [1]; Krishnan Murugappan [1]; Adam Damry [1]; Colin Jackson [1]; Antonio Tricoli [2]; Anne Bruestle [1]; Patrick Kluth [1]

[1] *Australian National University*

[2] *University of Sydney and Australian National University*

We present single-molecule level sensing of biomarkers by a solid-state nanopore sensor, a next-generation nanoelectronic sensor, as a diagnostic tool at ultra-low concentrations and volumes. We are now exploring protocols to operate in complex samples like blood and saliva.

Poster session / **174**

Coupled mode theory for BECs in a square bipartite optical lattice.

Author: Abbas Hussein[1]

[1] *ANU*

We apply the coupled-mode theory to study the steady state of BECs loaded into the p-band of a 2D bipartite optical lattice potential. We demonstrate the possibility to create a superposition of Bloch states with a nontrivial orbital texture.

Poster session / **176**

Increasing silica loading in fibre preform fabrication by 3D DLP printing

Author: Jiaying WANG[1]

Co-authors: Gang-Ding PENG [1]; Jianzhong ZHANG [2]; Jing KONG [1]; Yanhua LUO [1]; Yushi CHU [2]

[1] *1 Photonics and Optical Communications, School of Electrical Engineering & Telecommunications, University of New South Wales, Sydney, NSW 2052, Australia 2 Materials and Manufacturing Futures Institute, UNSW Sydney, NSW 2052, Australia*

[2] *1 Key Laboratory of In-fiber Integrated Optics of Ministry of Education, College of Physics and Optoelectronic Engineering, Harbin Engineering University, Harbin 150001, China 2 Fiber Optical Sensing Center for Excellence, Yantai Research Institute & Graduate School, Harbin Engineering University, Yantai 264000, China*

The processing of UV curable resin for manufacturing 3D fibre preforms based on DLP technology has been investigated. Fibre preforms with higher silica loading have been successfully fabricated.

Poster session / **177**

Infrared-to-Telecom Frequency Conversion in an Atom-Filled Hollow-Core Fibre

Author: Jed Rowland[None]

Co-authors: Andre Luiten [1]; Ben Sparkes [2]; Christopher Perrella [1]; Rachel Offer [1]; Till Weinhold [3]

[1] *University of Adelaide*

[2] *Defence Science and Technology Group*

[3] *University of Queensland*

We characterise near-IR to telecom frequency conversion via four-wave mixing in a rubidium-filled hollow-core fibre to allow for information transfer between efficient quantum memories within a fibre-based quantum network.

Australian and New Zealand Conference on Optics and Photonics / **178**

Spatial and Spectral High-Speed Optical Fibre Characterization

Author: Marcos Maestre Morote[None]

Co-authors: Joel Carpenter ; Martin Ploschner [1]; Mickael Mounaix

[1] *School of ITEE, The University of Queensland*

We built an apparatus that measures high-speed spectrally resolved mode transmission matrices. The field and modal coefficients were extracted at 3.8KHz, four times faster than the acquisition rate. This speed enables potential applications such as real-time imaging though multimode fibres.

Poster session / **179**

Electronic properties of 1T-TiSe2, numerical models of the formulation and melting of the charge density wave state

Author: Joshua Gray[1]

Co-authors: Jackson Smith [1]; Jared Cole [1]

[1] *RMIT University*

We use dynamical mean-field theory in conjunction with density functional theory and time-dependent Ginzburg-Landau formalism to investigate the electronic properties of the charge density wave (CDW) material 1T-$TiSe_2$ to better understand the formation and melting of the CDW state.

Australian and New Zealand Conference on Optics and Photonics / **180**

Complete Conversion of Unpolarised to Polarised Light with Metasurfaces

Authors: Neuton Li[None]; Shaun Lung[None]; Jihua Zhang[None]; Dragomir Neshev[None]; Andrey Sukhorukov[None]

We design and experimentally demonstrate topologically optimised free-form metasurfaces that efficiently convert unpolarised light from LEDs or other common sources to the same pure output polarisation, exceeding the 50% limit of conventional polarisers.

Focus Session / **181**

Inverse-Designed Metasurfaces for High-Efficiency Sum Frequency Generation

Authors: Neuton Li[None]; Jihua Zhang[None]; Dragomir Neshev[None]; Andrey Sukhorukov[None]

We developed an inverse design scheme to optimise the design of nonlinear metasurfaces for sum-frequency generation with any combination of optical wavelengths, achieving a high efficiency exceeding unpatterned films by several orders of magnitude.

Conference on Optoelectronic and Microelectronic Materials and Devices / **183**

A study of mechanical and optoelectronic properties of curved HgCdTe thin films

Author: Shuo Ma[None]

Co-authors: Wen Lei [1]; Lorenzo Faraone [1]; Wenwu Pan [1]; Zekai Zhang [1]

[1] *The University of Western Australia*

In this work, HgCdTe infrared detectors are taken as an example to simulate and study the mechanical and optoelectronic properties of HgCdTe infrared material under curved conditions in order to understand the feasibility of fabricating curved HgCdTe image sensors.

AIP: Atomic and Molecular Physics / 185

Feedback cooling atomic gases to quantum degeneracy

Author: Matthew Goh[1]

Co-authors: Zain Mehdi [2]; Richard Taylor [2]; Ryan Thomas [2]; Ashton Bradley [3]; Michael Hush [4]; Joseph Hope [2]; Stuart Szigeti [2]

[1] *University of Oxford*

[2] *The Australian National University*

[3] *University of Otago*

[4] *Q-CTRL*

We propose a new, low-loss method of cooling neutral alkali atoms to quantum degeneracy by optical feedback control. We present full-field quantum simulations demonstrating the viability of the technique, and show robustness to realistic experimental imperfections.

AIP: Quantum Science and Technology / 186

Filtering, Retrofiltering and Smoothing: Optimal quantum state estimation using continuous measurement

Author: Kiarn Laverick[1]

Co-authors: Areeya Chantasri [2]; Howard Wiseman [1]

[1] *Griffith University*

[2] *Mahidol University, Griffith University*

In this work we formally define the retrofiltered quantum state using the quantum state smoothing formalism and Bayesian estimation theory. Additionally, we are able to define a total of 9 different estimators using this framework, of which 3 are novel.

Australian and New Zealand Conference on Optics and Photonics / 187

Phase contrast imaging with thin film notch filters

Author: Shaban Sulejman[1]

Co-authors: Ann Roberts [2]; Lukas Wesemann [2]; Niken Priscilla [1]; Timothy J. Davis [2]; Wendy Lee [1]

[1] *ARC Centre of Excellence for Transformative Meta-Optical Systems, School of Physics, The University of Melbourne, Victoria 3010, Australia*

[2] *University of Melbourne, ARC Centre of Excellence for Transformative Meta-Optical Systems*

Notch filters are band-stop filters used to eliminate unwanted temporal frequencies. Here we demonstrate their capacity for phase contrast imaging of transparent objects enabled by its selective transmission. Applications in unstained biological imaging are anticipated.

Precision and Quantum Sensing Workshop / 188

DC magnetometry below the Ramsey limit with rapidly rotating diamonds

Author: Alexander Wood[1]

Co-authors: Alastair Stacey [2]; Andy Martin [1]

[1] *University of Melbourne*

[2] *RMIT University*

I will report on our demonstration of dc magnetometry that exceeds the sensitivity of T_2^*-limited Ramsey sensing by more than an order of magnitude. Our work demonstrates that diamond magnetometry below the T_2^* limit is possible.

Poster session / 189

Scalable and Effective use of Immersive Virtual Reality for Physics Education

Author: John Debs[1]

[1] *Research School of Physics, The Australian National University*

We have developed software and present significant evidence for how virtual reality can be used to correct common misconceptions of introductory physics students when learning Newtonian mechanics. Compared with standard instruction, students using VR improve their FCI scores by 13%.

Poster session / 190

Microneedles for Biofluid Sampling

Author: SACHIN KUZHUMBITHAZHATHU SHAJIL[1]

[1] *University of Melbourne*

A microneedle is a biomedical device that could be used for painless administration and extraction of fluids into an individual.
This study details the process of creating a patch of diamond microneedle and optimising its properties.

AIP: Quantum Science and Technology / 191

Expected Trapped-Ion Fast Gate Performance with Ultrafast Pulsed Lasers

Author: Kenji Shimizu[1]

Co-authors: Erik Streed [1]; Jordan Scarabel [1]

[1] *Griffith unversity*

Fast two-qubit phase gates with trapped-ions are feasible with an expected gate fidelity of 77.8% using a sequence of our ultrafast picosecond laser π-pulses. Such sub-microsecond gate operations support the development of scalable quantum computers.

AIP: Atomic and Molecular Physics / 192

Dark matter detection via atomic interactions

Authors: Ashlee Caddell[1]; Benjamin Roberts[1]

[1] *The University of Queensland*

Presentation of atomic excitation factors and calculated event rates for DM-electron scattering, and how they compare to the excess seen in the XENON1T experiment.

AIP: Condensed Matter, Materials and Surface Physics / 193

Origin of Discontinuous Negative Differential Resistance in Metal-Oxide-Metal Devices

Author: Sanjoy Nandi[1]

[1] *The Australian National University*

Metal-insulator-transition, threshold switching, negative differential resistance, Schottky-barrier, current bifurcation

AIP: Quantum Science and Technology / 194

Quantum steering with vector vortex photon states with the detection loophole closed

Author: Farzad Ghafari[1]

Co-authors: Dominick Joch [1]; Sergei Slussarenko [1]; Nora Tischler [1]; Lynden Shalm [2]; Varun Verma [2]; Sae Woo Nam [2]; Geoff Pryde [3]

[1] *Griffith University*

[2] *NIST*

[3] *PsiQuantum*

Quantum nonlocality is a resource that enables secure quantum information tasks. Steering nonlocality is a scenario where one party is in a secure location and another party is not. Here, we show detection-loophole-free quantum steering, using a vector-vortex state encoding.

Poster session / **195**

Fibre optic hydrophone based on pressure sensitive microstructed optical fibre

Authors: Linh Viet Nguyen[1]; Mohammad Istiaque Reja[1]; Stephen Warren-Smith[None]; Wen Qi Zhang[1]

[1] *University of South Australia*

A pressure-sensitive microstructured optical multimode fibre is used to build a hydrophone using a homodyne detection configuration. The fibre hydrophone is tested again a commercial piezo-electric hydrophone and shows similar performance across the whole audio frequency band.

AIP: Atomic and Molecular Physics / **196**

Berezinskii-Kosterlitz-Thouless transitions in a ferromagnetic superfluid

Authors: Andrew Groszek[None]; Andrew Underwood[None]; Lewis Williamson[None]; P. Blair Blakie[None]; Xiaoquan Yu[None]

We explore finite-temperature phases of a spin-1 ferromagnetic Bose gas, identifying mass and spin BKT transitions, a vortex plasma phase, and novel critical scaling of spatial correlations.

Poster session / **197**

A degenerate mixture of ^{3}He* and ^{4}He* with 3D single particle resolution

Author: Kieran Thomas[None]

Co-authors: Andrew Truscott ; Bryce Henson ; Sean Hodgman

We present our experimental realisation of a degenerate mixture of ^{4}He [bosonic] and ^{3}He [fermionic], with ^{4}He $T/T_C \sim 0.3$, and ^{3}He $T/T_F \sim 0.1$, in the metastable state 2^3S_1. The large internal energy of the metasable state allows for far-field single-particle 3D reconstruction.

AIP: Condensed Matter, Materials and Surface Physics / **198**

Vibrational Properties Beyond Debye Model

Author: Dehong Yu[None]

While the Debye model has served as the fundamental law for bulk solid materials for over 100 years, recently new laws are discovered for liquid phase and nanoconfined solid materials.

Poster session / **199**

PELICAN –a Time of Flight Cold Neutron Spectrometer – Recent Scientific Highlights

Author: Dehong Yu[None]

Co-author: Richard Mole

The recent Scientific highlights from the Pelican - time of flight cold neutron spectrometer will be presented.

AIP: Atomic and Molecular Physics / **200**

Towards an experimental violation of a motional-state Bell's inequality using ultracold helium

Author: Kieran Thomas[None]

Co-authors: Andrew Truscott ; Bryce Henson ; Sean Hodgman

We present our experimental progress towards demonstrating quantum non-locality in a matter wave system of ultracold helium via a Rarity-Tapster interferometer. The momentum entangled state used for the violation is generated by colliding helium Bose-Einstein condensates.

AIP: Theoretical and Mathematical / **201**

Particle-like Interactions of Two-Dimensional Solitary Waves in Continuous Media

Author: Yury Stepanyants[None]

The interaction of solitary waves in continuous media described by Kadomtsev-Petviashvili type equations is studied. The theoretical concept of particle-like soliton interactions in two-dimensional media is developed and illustrated by examples.

AIP: Theoretical and Mathematical / **202**

Bandlimtied quantum fields and their continuous and discrete properties

Author: Dominic Lewis[1]

[1] *RMIT University*

We use bandlimitation to express quantum fields as simultaneously continuous and discrete, showing that discrete fields posess continuous translational symmetry and taking us a step towards unifying quantum field theory with general relativity.

Australian and New Zealand Conference on Optics and Photonics / 203

Smart silk membrane: Hybrid optical platform for wound sensing applications

Author: Asma Khalid[1]

Co-authors: Achini Vidanapathirana [2]; Allison Cowin [3]; Amanda N Abraham [4]; Azim Arman [2]; Brant C Gibson [4]; Christina Bursill [5]; DOngbi Bai [1]; Denver Linklater [1]; Elena Ivanova [1]; Ethan Ellul [1]; Fiona Wood [6]; Georgy Kalenkov [2]; Hanif Haidari [3]; Jean-Philippe Tetienne [1]; Jiawen Li [2]; Laura Hung [4]; Lu Peng [2]; Mark Fear [6]; Rob McLaughlin [2]; Shadi Houshyar [7]; Suzanne Rea [6]; Zlatko Kopecki [3]

[1] *RMIT University*

[2] *University of Adelaide*

[3] *University of South Australia*

[4] *ARC Centre of Excellence for Nanoscale Biophotonics, School of Science, RMIT University, Melbourne, Victoria 3000, Australia*

[5] *SAHMRI*

[6] *University of Western Australia*

[7] *School of Engineering, RMIT University, Melbourne, Victoria 3000, Australia*

Our work aims to develop a naturally extracted, transparent silk fibroin dressing, integrated with temperature and pH sensors, capable of monitoring early signs of infections, healing disruptions and scar formation via light-based measurements.

AIP: Quantum Science and Technology / 204

Quantum Enhanced Robustness in Adversarial Machine Learning

Author: Maxwell West[1]

Co-authors: Shu Lok Tsang [1]; Jia Shun Low [1]; Charles Hill [1]; Martin Sevior [1]; Christopher Leckie [1]; Lloyd Hollenberg [1]; Sarah Erfani [1]; Muhammad Usman [1]

[1] *The University of Melbourne*

Machine learning models are susceptible to *adversarial examples* - inputs to the model which have been manipulated in order to confuse it. We study the vulnerability and resiliency of quantum classifiers to such inputs.

Australian and New Zealand Conference on Optics and Photonics / 205

Establishing the Bio-interface for Neural Electrophysiology with a Diamond Voltage Imaging Microscope

Author: Daniel McCloskey[1]

Co-authors: David Simpson [1]; Hunter Johnson [1]; Nikolai Dontschuk [1]; Samira Falahatdoost [2]; Steven Prawer [1]; Wei Tong [2]

[1] *The University of Melbourne School of Physics*

[2] *National Vision Research Institute, Australian College of Optometry*

I will present our recent results detailing the design and fabrication of a diamond-based optical voltage imaging platform, and our progress to date in realizing intracellular electrophysiological recordings of mammalian neurons using this new optoelectronic biosensor technology.

AIP: Nuclear and Particle Physics / 206

B Meson Flavour Tagging via Quantum Machine Learning

Author: Maxwell West[None]

Co-authors: Martin Sevior [1]; Muhammad Usman [1]

[1] *The University of Melbourne*

We investigate employing quantum machine learning algorithms for B meson flavour tagging, an important component of the experiments at Belle-II which study heavy quark mixing, CP violation and the matter-antimatter asymmetry of the universe.

AIP: Quantum Science and Technology / 207

Transversal Injection: A method for direct encoding of ancilla states for non-Clifford gates using stabiliser codes.

Author: Jason Gavriel[1]

[1] *University of Technology Sydney*

I would like to apply for a talk (preferred) or poster. I am the primary author of the paper and the one which will present.

Please find attached the abstract in .pdf format.

Poster session / 208

Effect of the silicon substrate on singlet and triplet exciton binding energy in crystalline tetracene

Authors: Mykhailo Klymenko[1]; Jared Cole[1]

[1] *ARC Centre of Excellence in Exciton Science, RMIT University*

We study the effect of the inorganic semiconductor substrate on the exciton binding energies in the crystalline tetracene and its implications for the singlet fission effect.

AIP: Condensed Matter, Materials and Surface Physics / 209

Prediction of exciton condensation in biased bilayer graphene

Author: Oleg Sushkov[None]

Co-author: Harley Scammell [1]

[1] *UNSW*

We predict that at appropriate tuning of bias suspended bilayer graphene undergoes quantum phase transition from band insulator to excition insulator. The corresponding critical temperature can reach up to 70K

Poster session / 210

Homodyne measurement with a Schrödinger cat state as a local oscillator

Author: Austin Lund[None]

Co-author: Joshua Combes [1]

[1] *University of Colorado Boulder*

We present a new approach to analysing homodyne measurement using Schrödinger-cat states as local-oscillators and give the characteristics of this type of measurement for various different input states.

Focus Session / 211

Topologically optimized metasurface for characterizing two-photon distinguishability in a single shot

Author: Jinyong Ma[1]

Co-authors: Andrey Sukhorukov [2]; Jihua Zhang [2]; Neuton Li [2]; Shaun Lung [2]

[1] *Research School of Physics, The~Australian National University, Canberra, ACT 2601, Australia*

[2] *ARC Centre of Excellence for Transformative Meta-Optical Systems (TMOS), Research School of Physics, The Australian National University, Canberra, ACT 2601, Australia.*

We propose and fabricate a static dielectric metasurface that enables single-shot characterization of the distinguishability between two photons with high transmission efficiency and tolerance to measurement noise.

Australian and New Zealand Conference on Optics and Photonics / 212

Correction of quantum phase errors with integrated photonic circuits

Author: Jinyong Ma[1]

Co-authors: Andrey Sukhorukov [2]; Jihua Zhang [2]; Kai Wang [3]; Neuton Li ; Qingquan Yao [2]

[1] *Research School of Physics, The~Australian National University, Canberra, ACT 2601, Australia*

[2] *ARC Centre of Excellence for Transformative Meta-Optical Systems (TMOS), Research School of Physics, The Australian National University, Canberra, ACT 2601, Australia.*

[3] *Department of Electrical Engineering, Stanford University, Stanford, California 94305, U.S.A*

We introduce a protocol for detection and correction of arbitrary continuous phase errors in a multi-channel quantum transmission system by integrated waveguide circuits.

Poster session / **213**

Laser Generation via Light–Emitting One–Dimensional Narrow Bandwidth Nanoporous Photonic Crystals

Author: Satyathiran Gunenthiran[None]

Co-authors: Juan Wang [1]; Cheryl Suwen Law [1]; Siew Yee Lim [1]; Heike Ebendorff-Heidepriem ; Abel Santos

[1] *The University of Adelaide*

Optical engineering of nanoporous photonic crystals to achieve high–quality lasing

AIP: Solar Terrestrial and Space Physics / **215**

Modelling Cosmic Radiation Events in the Tree-ring Radiocarbon Record

Author: Benjamin Pope[1]

Co-authors: Jordan Dennis [1]; Margot Kuitems [2]; Mathew Owens [3]; Mike Dee [2]; Qingyuan Zhang [1]; Ulf Büntgen [4]; Utkarsh Sharma [1]

[1] *University of Queensland*

[2] *University of Groningen*

[3] *University of Reading*

[4] *University of Cambridge*

Tree ring radiocarbon reveals ‘Miyake events’: rare bursts of cosmic radiation, larger than the greatest solar flares. Using our new open source Bayesian carbon cycle code, we reanalyse all published data, rejecting false positive events and challenging previous models.

AIP: Nuclear and Particle Physics / **216**

The Quark-Gluon Interactions in Low Energies

Author: Ayse Kizilersu[1]

Co-authors: Jonivar Skullerud [2]; Paulo Silva [3]; Andre Sternback [4]; Orlando Oliveira [3]

[1] *University of Adelaide*

[2] *University of Maynooth*

[3] *University of Coimbra*

[4] *Friedrich-Schiller University*

The quark-gluon vertex is an important ingredients of one of the strong interaction. It is an essential ingredient in functional approaches to nonperturbative quantum chromodynamics. We will summarise the latest developments in quark-gluon vertex and its implications in hadron physics.

AIP: Theoretical and Mathematical / 217

Universal Behavior in the Stock Market - Order in Chaos

Author: Ayse Kizilersu[1]

Co-authors: Anthony Thomas [1]; Markus Kreer

[1] *University of Adelaide*

We will be discussing the behaviour of the electronic order book in terms of its ingredients : arrival/cancellation time, waiting-time, inter-trade time. The London stock exchange data is used in this study and its analysis will be discussed.

Poster session / 219

Non-perturbative solution to quantum parametric down-conversion in open optical systems

Author: Aleksa Krstić[1]

[1] *Abbe Center of Photonics, Institute of Applied Physics, Friedrich-Schiller University Jena*

We develop a non-perturbative description of spontaneous parametric down-conversion in the high-gain regime for nanostructured systems with arbitrary amounts of loss and arbitrary dispersion. As an example, we use it numerically to investigate integrated quantum spectroscopy at high gain.

Poster session / 220

Modelling of Nonlinear Amplifier in the Mid-IR Region

Author: Bhaswar Dutta Gupta[1]

Co-authors: Ian Hendry [1]; Stanley Tang [1]; Miro Erkintalo [1]; Claude Aguergaray [1]

[1] *University of Auckland*

We use an improved numerical model to demonstrate the advantages in terms of increased average power and spectral broadening while generating a supercontinuum using a nonlinear amplifier over the traditional method of using an amplified pulse seeding a passive fibre.

Poster session / 221

Optical remote sensing of subsurface water temperature and salinity

Author: Glen Douglass[1]

Co-authors: Carolyn Taylor [1]; Herman Li [1]; Diana Dalae [1]; Brad Neimann ; James Downes [1]; judith dawes [2]; Ondrej Kitzler [1]; David Spence ; Helen Pask [1]

[1] *Macquarie University*

[2] *Macquarie university*

Methods for Optical remote sensing of subsurface water properties such as temperature and salinity will be described, along with the transition of successful lab studies to the field. Challenges and achievements will be presented.

AIP: Theoretical and Mathematical / 222

Bohmian trajectories and nonlocality in relativistic two-photon interactions

Author: Joshua Foo[None]

Co-authors: Austin Lund ; Timothy Ralph

We recently devised a weak-measurement model for calculating the relativistic Bohmian trajectories of photons. Here, I discuss an extension of this model to include relativistic two-photon interactions, and calculate the nonlocal Bohmian trajectories for photons in a position-symmetrised state.

Poster session / 223

Exploring the Properties and Stabilization of Nanoscale Overlayer/Metal cluster Architectures.

Authors: Gunther Andersson[1]; Heike Ebendorff-Heidepriem[2]; Mohammed Asiri[3]

Co-author: Greogy Metha [4]

[1] *G. Andersson*

[2] *H. Ebendorff-Heidepriem*

[3] *M.Asiri*

[4] *G. Metha*

Stiblaistion of metal clusters in the surface by adding an overlayer of metal oxide using ALD, it is expected to prevent the agglomeration and stabilise metal clusters on the surface for applications in catalysis, photocatalysis, medical devices, and sensors.

AIP: Quantum Science and Technology / 224

Method for in-solution, high-throughput T1 relaxometry using fluorescent nanodiamonds

Authors: Brant C Gibson[1]; David Simpson[2]; Ella Walsh[3]; Erin Grant[3]; Gawain McColl[4]; Liam Hall[5]; Mina Barzegar Amiri Olia[6]; Philipp Reinick[7]

[1] *ARC Centre of Excellence for Nanoscale Biophotonics, School of Science, RMIT University, Melbourne, Victoria 3000, Australia*

[2] *The University of Melbourne School of Physics*

[3] *The University of Melbourne*

[4] *Florey Institute of Neuroscience and Mental Health*

[5] *School of Chemistry, the University of Melbourne*

[6] *Bio 21 Institute*

[7] *RMIT University*

We have developed a measurement platform that can report the T1 spin lattice relaxation time from an ensemble of fluorescent nanodiamonds in solution. This platform can be used for rapid material characterisation and chemical sensing in a convenient cuvette-based approach.

AIP: Nuclear and Particle Physics / 225

Lattice QCD Determination of Transverse Force Distributions in the Proton

Author: Joshua Crawford[None]

Co-authors: James Zanotti [1]; Ross Young

[1] *The University of Adelaide*

Transverse force tomography is a relatively new technique that offers an alternative perspective on confining forces in Quantum Chromodynamics. We present the first lattice QCD computation of the spatial distribution of the “Colour-Lorentz” forces in the proton.

Poster session / 226

Heralded photons over 75km of bright fibre using Type II SPDC

Authors: Mark Baker[None]; Michael Hencz[None]

Co-author: Erik Streed [1]

[1] *Griffith unversity*

In this project, we are presenting our methodology for generating and detecting single heralded photons over approximately 75km of field deployed fibre which is also in use by the Griffith University IT department for classical networking purposes.

AIP: Theoretical and Mathematical / 227

Topology, quantum gravity and particle physics

Author: Archil Kobakhidze[None]

In this talk, I will describe how the non-trivial topology of curved spacetime induces quantum tunnelling between vacuum states that profoundly affect the properties and interactions of elementary particles. Namely, I will argue that gravitational instantons cause combined parity violation.

Poster session / **228**

Microscopic theory of excitons bound by light

Author: Sangeet Santhosh Kumar[1]

Co-authors: Jesper Levinsen [1]; Meera Parish [1]

[1] *Monash University*

Theoretical investigation of excitons in semiconductor quantum-well designed not to have Coulomb bound excitions, but shows excitons bound by photons when placed in optical microcavity. The spectrum is calculated from theory and compares well with recent Nature Physics experiment spectrum.

Conference on Optoelectronic and Microelectronic Materials and Devices / **229**

The Application of Gallium Oxide High Power Optical Devices by Etching Process Optimization

Author: Xiting Zhou[None]

Co-authors: David Lewis ; Yong Cheow Lim ; Yan Jiao ; Nelson Tansu ; Philip van Eyk ; Petar Atanackovic

β-Ga2O3 gratings were fabricated by inductively-coupled-plasma (ICP) etching process to have a clearer understanding of dry etching mechanism during semiconductor device manufacturing process. Different parameters were adjusted to investigate their effects and find the best etching recipe.

Poster session / **230**

Symmetry of guided mode resonances in 2D nonlocal metasurfaces

Author: Matthew Parry[None]

Co-authors: Jihua Zhang [1]; Dragomir Neshev [1]; Andrey Sukhorukov [1]

[1] *Australian National University*

We use symmetry analysis of metasurfaces on thin film to determine the vector field profiles of the modes and thus calculate coupling to radiation channels, mode overlaps and the nonlinear polarisation of sum frequency generation.

Poster session / **231**

Unepected developments in the Plasma Physics of Welding, Lightning and Swirching Arcs.

Author: John Lowke[1]

[1] *University of South Australia*

Plasma Physics has made surprising separate contributions to Welding, Lightning and Circuit interruption.

AIP: Relativity and Gravitation / **232**

Quantum signatures of a mass-superposed black hole

Author: Joshua Foo[None]

Co-authors: Cemile Senem Arabaci ; Magdalena Zych [1]; Robert Mann [2]

[1] *University of Queensland*

[2] *University of Waterloo*

In quantum gravity, it is anticipated that there exist "quantum superpositions of spacetime". Here, I develop a framework for constructing such superpositions to analyse a mass-superposed black hole. My results corroborate Bekenstein's conjecture for the mass quantisation of black holes.

Poster session / **233**

Telefilters, telemirrors, and causality

Author: Joshua Foo[None]

Co-authors: Magdalena Zych [1]; Sho Onoe [2]; Timothy Ralph

[1] *University of Queensland*

[2] *University of Montreal*

In this talk, I demonstrate how mode-selective interactions, ubiquitous in quantum optics and field theory, lead to causality violations. I resolve this problem by showing that such interactions necessarily induce a fundamental time-delay in the propagation of input modes.

AIP: Group for Astroparticle Physics / Astronomy / **234**

Constraints on Light Dark Matter from Cosmic Ray Upscattering

Authors: Iman Shaukat Ali[None]; Jayden Newstead[None]; Nicole Bell[None]

Models with large cross sections require light mediators and are subject to other constraints. We use the direct detection of CR-upscattered DM to compute limits on the coupling, and compare these with constraints arising from other experiments and observations.

AIP: Quantum Science and Technology / 235

Certified random numbers from quantum steering

Author: Sergei Slussarenko[None]

Co-author: Dominick Joch

Certified quantum randomness protocols can securely guarantee random numbers that are unpredictable to any physical observer. We experimentally implement one such protocol based on quantum steering using single photons.

AIP: Nuclear and Particle Physics / 236

Pyrate: a novel system for data transformations, reconstruction and analysis for the SABRE experiment

Author: Michael Mews[None]

Co-author: Federico Scutti [1]

[1] *Swinburne University of Technology*

This presentation addresses the design and implementation of the pyrate software system developed within the context of the SABRE experiment for dark matter direct detection. The system is oriented at processing and analysing the data collected by the experiment.

AIP: Atomic and Molecular Physics / 238

Close-Coupling Approach to Differential Ionisation in Ion-Atom Collisions

Author: Alisher Kadyrov[1]

Co-authors: Kate Spicer [1]; Corey Plowman ; Shukhrat Alladustov [1]; Ilkhom Abdurakhmanov [2]; Igor Bray [1]

[1] *Curtin University*

[2] *Pawsey Supercomputing Centre*

We report on recent progress in applications of the convergent close-coupling approach to ion-atom collisions. The approach allows one to take into account all underlying processes of excitation, ionisation, and electron capture into bound and continuum states of the projectile.

AIP: Condensed Matter, Materials and Surface Physics / 239

Electrically tuneable terahertz metasurface enabled by a graphene/gold bilayer structure

Author: Andrew Squires[1]

Co-authors: Adrian Murdock ; Dong Han Seo ; James Cooper ; Jia Du ; Simon Lam ; Tim van der Laan ; Ting Zhang ; Xiang gao ; Zhaojun Han

[1] *CSIRO*

We present a highly tuneable terahertz (0.2THz) frequency selective absorber. The device is based on a graphene/gold bilayer which is patterned/etched into a cross-slot metamaterial structure. This provides high resonant quality from the gold and tuneability from the graphene.

AIP: Solar Terrestrial and Space Physics / 240

Ionospheric Corrections for High Frequency Line of Sight Satellite Observations During Solar Minimum

Author: Tristan Camilleri[None]

Co-author: Manuel Cervera

Ionospheric corrections are applied to satellite observations made using a high frequency line of sight radar during solar minimum using numerical ray-tracing. Results showed mean error in satellite position compared to two-line-element propagation decreased to within 1 km.

AIP: Quantum Science and Technology / 241

Noise mitigation via a quantum autoencoder

Author: Nora Tischler[None]

Co-author: Dominick Joch

Quantum autoencoders use machine learning techniques to compress quantum data and are predicted to be useful for noise mitigation. Our ongoing work aims to experimentally demonstrate denoising of four-dimensional quantum states.

AIP: Condensed Matter, Materials and Surface Physics / 242

Cobalt Phthalocyanine Active Site Tuning via Atomic Linker Immobilisation for CO2 Electroreduction

Author: Oliver Conquest[None]

A density functional theory investigation of cobalt-centred phthalocyanine active site tuning via atomic linker immobilisation for the CO2 electroreduction reaction. Electronic properties, geometries and free energy reaction pathways are calculated to determine the best performing systems.

Poster session / 243

Accurate modelling of femtosecond-laser direct written fibre Bragg Gratings

Author: Saurabh Bhardwaj[None]

Modelling and experimental results of femtosecond-laser inscribed point-by-point Bragg gratings were compared. Coupled mode theory model doesn't account for the distorted mode and fails whereas Bloch function approach consider distorted mode and provides a more accurate picture of grating dynamics.

Poster session / **244**

Tunable Optical Grating in Magnetic Nanofluid

Authors: Urveshkumar Soni[1]; Rucha Desai[1]

[1] *Charotar University of Science and Technology*

The optical and chemical properties of the magnetic nanofluid can be altered using a magnetic field. The magnetic nanofluid shows tunability in the diffraction angle under a magnetic field. Hence, magnetic nanofluid is the potential candidate to prepare soft grating.

Australian and New Zealand Conference on Optics and Photonics / **245**

Temperature-dependent synchrotron absorption measurements of MgO:LiNbO3

Author: Ameera Jose[1]

Co-authors: Ondrej Kitzler [1]; Helen Pask [1]; David Spence [1]

[1] *MQ Photonics Research Centre, School of Mathematical and Physical Sciences, Faculty of Science and Engineering, Macquarie University*

We report synchrotron absorption measurements for MgO:LiNbO3 over a wide range of wavenumbers and temperatures. Spectra reveal the existence of an unexpected mode at 3.15 THz at all temperatures which explains the crystal's difficulty of THz generation at higher frequencies.

AIP: Group for Astroparticle Physics / Astronomy / **246**

CTA status and Oz-MWL linkages

Authors: Gavin Rowell[1]; Miroslav Filipovic[None]

[1] *University of Adelaide*

The CTA is the next generation ground-based high-energy gamma-ray telescope, constructed-operated by 25 countries. Its Key Science span Galactic/Extragalactic, time-domain and fundamental (astro)physics. Australian participation in CTA is through a consortium of 7 universities, with additional AAL funding and support.

AIP: Quantum Science and Technology / **247**

Analog Control of the Diamond Quantum Processor

Author: Sophie Stearn[1]

Co-author: Marcus Doherty [2]

[1] *The Australian National University*

[2] *Australian National University*

Different methods for compiling analog quantum control pulses for the diamond quantum processor, speed and error benefits of using analog control, and semi-analytical optimisation of analogue control pulses.

Australian and New Zealand Conference on Optics and Photonics / 248

Automation and measurement geometry of stimulated-polariton-scattering based THz spectrometric systems

Author: Ondrej Kitzler[1]

Co-authors: Ameera Jose [1]; David Spence [1]; Helen Pask [1]

[1] *Macquarie University*

Ultra-fast THz sources have been implemented into spectrometers offering small form-factor and broadband coverage. However, their low spectral power limits use to very thin samples. Here we demonstrate implementation of high power tunable SPS lasers into a spectrometric system.

Joint session: AIP-BMP / COMMAD / 249

Fluorescence-based Fibre Optic Sensor for Hydrogen Sulphide Detection

Author: Shaghayegh Baghapour[1]

Co-authors: Sally Plush [2]; Shahraam Afshar Vahid [1]; Stephen Warren-Smith [3]; Wen Qi Zhang [1]

[1] *Laser Physics and Photonic Devices Laboratories, University of South Australia, SA 5095, Australia*

[2] *Clinical and Health Sciences, University of South Australia, SA 5000, Australia*

[3] *Future Industries Institute, University of South Australia, SA 5095, Australia*

A fluorescnece-based fibre optic sensor has been developed to detect hydrogen sulfide. Optical fibre functionalized with HS-sensitive fluorophore shows an increase in the fluorescence emission upon reaction with HS, the similar behaviour to when fluorophore is dissolved in the solution.

AIP: Theoretical and Mathematical / 250

Scattering Amplitudes of Massive Spin-2 Kaluza-Klein Particles

Author: Dipan Sengupta[1]

[1] *University of Adelaide*

Compactified extra dimensions are well motivated BSM candidates. I will talk about the behaviour of scattering amplitudes of Kaluza-Klein gravitons in both flat and warped extra dimensions and assess the range of validity of the low-energy effective Kaluza-Klein theory.

AIP: Computational and Mathematical Physics / 251

Autonomous Nanomechanical Error Correction

Author: Xiaoya Jin[None]

Co-author: Glen Harris [1]

[1] *University of Queensland*

In this talk, I will discuss recent developments in the field of nanomechanical computing. Specfically, I will propose the first error correction architecture for integrated nanomechanical systems that uses majority voting logic.

Poster session / 252

Nanoporous Anodic Alumina based Iontronic Sensing via Structural Engineering

Author: Juan Wang[None]

Co-authors: Cheryl Suwen Law [1]; Satyathiran Gunenthiran ; Huong Nguyen Que Tran [1]; Khoa Nhu Tran [1]; Siew Yee Lim [1]; Abel Santos

[1] *The University of Adelaide*

Engineering of the structure of nanoporous anodic alumina for iontronic sensing

AIP: Theoretical and Mathematical / 253

Unruh-DeWitt Detectors with Relativistic Centre of Mass

Author: Evan Gale[1]

Co-author: Magdalena Zych [1]

[1] *University of Queensland*

We consider a relativistic UDW detector model with first-quantised centre of mass, which we compare to a full field-theoretic description. We analyse the transition rate to first-order in perturbation theory for different types of minimum uncertainty state.

AIP: Nuclear and Particle Physics / 254

The emergent origin of mass

Author: Waseem Kamleh[1]

[1] *University of Adelaide*

Where does your mass come from? The Higgs mechanism only accounts for 1% of the proton mass. We reveal how centre vortices connect emergent phenomena such as quark confinement and dynamical mass generation with the QCD vacuum state.

Poster session / 255

Misconception Linked to Missing Information in Figures of a First Year Physics Textbook & How it was Uncovered

Author: Deb Kane[None]

An example of student misconception of a physical concept in first year physics - energy quantisation - is described. This went undetected using standard assessment and was uncovered by descriptive writing assessment.

AIP: Condensed Matter, Materials and Surface Physics / 256

Glowworm Capture Threads Studied by AFM

Author: Deb Kane[1]

Co-authors: Bo-Ching He [2]; Dakota Piorkowski [3]; I-Min Tso [3]; Sean Blamires [4]

[1] *Australian National University*

[2] *Center for Measurement Standards, Industrial Technology Research Institute*

[3] *Department of Life Science, Tunghai University,*

[4] *Evolution and Ecology Research Centre, University of New South Wales*

Tapping mode atomic force microscopy was used to reveal nano-scale features and material variation near the surface of capture threads of glowworm (Arachnocampa tasmaniensis). Unstretched and stretched threads are contrasted.

Australian and New Zealand Conference on Optics and Photonics / 257

Development of an mid-infrared integrated optics 4-telescope beam combiner for the Hi-5 instrument

Authors: Ahmed Sanny[1]; Lucas Labadie[2]; Michael Withford[3]; Simon Gross[3]

[1] *University of Cologne, Macquarie University*

[2] *University of Cologne*

[3] *Macquarie University*

An integrated optic 4-telescope beam combiner is being developed for the detection of exoplanets using nulling interferometry. The beam combiner, fabricated using ultrafast laser inscription, is optimised for achromatic behaviour in the mid-infrared (3.5-4.0 μm).

AIP: Condensed Matter, Materials and Surface Physics / 258

Non-adiabatic transitions between valley states in a Si/SiGe heterostructure

Authors: Alan Gardin[None]; Tyler Whittaker[1]; Rajib Rahman[2]; Giuseppe Tettamanzi[1]; Ross Monaghan[1]

[1] *University of Adelaide*

[2] *The University of New South Wales*

We theoretically show the all-electrical control of the electron's two lowest valley states in a silicon/silicon-germanium heterostructure.

Australian and New Zealand Conference on Optics and Photonics / 259

Semiconductor Nanowire Arrays for Photonic Integration

Author: Lan Fu[1]

[1] *The Australian National University*

Semiconductor nanowire arrays have drawn much attention as nanoscale building blocks for integrated photonics, owing to their nanoscale size and unique material properties. In this talk, we present the study of nanowire array based materials and devices for photonic integration.

Poster session / 260

Silicon Birefringence Mapping Measurement

Author: Vahid Jaberian Hamedan[None]

Co-author: Alexander Adam

The project is regarding the mapping silicon test mass birefringence using an automated system. The measurement is based on a polarization modulation technique using a PEM. Our system can measure small Birefriengence of 10^-9.

Precision and Quantum Sensing Workshop / 261

High-bandwidth vector AC magnetometry using nitrogen-vacancy centres in diamond

Author: Michael Barson[1]

[1] *Monash University*

See abstract in attached word document.

Poster session / 262

Enabling the exploration of exotic imaging phenomena triggered by non-linear fluorophores in confocal systems

Authors: Denitza Denkova[1]; Antony Orth[2]; Samuel Ojosnegros[3]; Martin Ploeschner[4]

[1] *Institute for Bioengineering of Catalonia (IBEC)*

[2] *National Research Council of Canada, Ottawa, Ontario, K1K 3Y2, Canada*

[3] *Institute for BioEngineering of Catalonia (IBEC), 08028 Barcelona, Spain*

[4] *School of Information Technology & Electrical Engineering, Uni. of Queensland, Brisbane, 4072, Australia*

We present a powerful theoretical framework, organized as user-friendly open-source tool, for exploring image formation in confocal microscopes when using non-linear fluorophores. It allows extremely convenient image optimization and enables the unraveling and exploration of unexpected and exotic imaging phenomena.

Conference on Optoelectronic and Microelectronic Materials and Devices / 263

Fabrication of Superconducting Diamond Devices

Author: Manjith Bose[1]

Co-authors: Anders Barlow [1]; Christopher Pakes [2]; Daniel Creedon [1]; Georgina Klemmencic [3]; Grant van Riessen [2]; Michael Stuiber [4]; Oliver Williams [3]; Soumen Mandal [3]

[1] *The University of Melbourne*

[2] *La Trobe University*

[3] *Cardiff University*

[4] *Melbourne Centre for Nanofabrication (MCN)*

A novel fabrication methodology incorporating neon-ion milling is developed to engineer superconducting boron-doped diamond devices including the first diamond nano-SQUID, with noise properties (flux noise: 0.14 $\mu\phi_0/\sqrt{\text{Hz}}$ at 1 kHz, spin sensitivity: 11 spins/$\sqrt{\text{Hz}}$) comparable to optimal Nb-nano-SQUIDs reported.

Australian and New Zealand Conference on Optics and Photonics / 264

Hyper-spectral imaging methodology for classification of embryo metabolism

Author: Denitza Denkova[1]

Co-authors: Albert Parra Martinez [2]; Xavier Burgos-Artizzu [3]; Anna Seriola [2]; Ester Aroca [2]; Marc Casals [2]; Irene Olivera [4]; Scott Fraser [5]; Hsiao Chiang [5]; Francesco Cutrale [5]; Nuno Costa-Borges [6]; Enric Mestres [6]; Monica Acacio [6]; Gloria Calderon [6]; Elena Rebollo [7]; Anna Veiga [8]; Montse Boada [9]; Miquel Soler [9]; Monica Parriego [9]; Samuel Ojosnegros [2]

[1] *Institute for Bioengineering of Catalonia (IBEC)*

[2] *Institute for BioEngineering of Catalonia (IBEC), 08028 Barcelona, Spain*

[3] *Movumtech, Barcelona, Spain*

[4] *IVFTechnology, Barcelona, Spain*

[5] *Translational Imaging Center, University of Southern California, USA*

[6] *Embryotools, Barcelona, Spain*

[7] *Molecular Imaging Platform, Institut de Biologia Molecular de Barcelona, Spain*

[8] *Barcelona Stem Cell Bank, Institut d'nvestigació Biomèdica de Bellvitge (IDIBELL), Barcelona, Spain*

[9] *Reproductive Medicine Service, Dexeus Mujer, Hospital Universitari Dexeus, Barcelona, Spain*

We present an optical methodology for classifying embryo metabolism based on hyper-spectral imaging and artificial intelligence. It successfully distinguishes oocytes from old and young mice and control from metabolically altered embryos, with potential to empower embryologists in in-vitro fertilization clinics.

AIP: Theoretical and Mathematical / 265

Progress toward uncovering the spin of a vortex

Author: Emil Johansen[None]

By adopting a Maxwell-Einstein picture of a (2+1)-dimensional superfluid it is predicted that vortex quasi-particles (kelvons) posses an intrinsic spin. We examine the possibility of implementing topological non-abelian geometric phases on such kelvon spins.

Conference on Optoelectronic and Microelectronic Materials and Devices / 267

High-Power Mid-IR Quantum Cascade Lasers grown by MOCVD

Author: Luke Mawst[1]

Co-authors: Jae Ha Ryu [1]; Jeremy Kirch [1]; Morgan Turville-Heitz [1]; Shining Xu [1]; Shuqi Zhang [1]; Dan Botez [1]; Benjamin Knipfer [2]; Robert Marsland [2]; Steve Jacobs [2]; Axel Strömberg [3]; Yan-Ting Sun [3]; Sebastian Lourdudoss [3]; Tom Earles [4]; Steven Ruder [4]; Kevin Oresick [4]; Chris Galstad [4]; Mike Klaus [4]; Suraj Suri [1]

[1] *University of Wisconsin-Madison*

[2] *Intraband , LLC*

[3] *KTH-Royal Institute of Technology*

[4] *DRS Daylight Solutions*

The growth of QCLs requires an understanding of the interfacial properties of the superlattice (SL) active region. Atomic probe tomography is used to elucidate the interfacial properties within the QCL, and incorporate these observed properties into advanced QCL designs.

Australian and New Zealand Conference on Optics and Photonics / 268

Laser Written Carbonised Porous Silicon Waveguides for Optical Sensor Applications

Author: Jesse Fletcher[1]

Co-authors: Adrian Keating ; Giacinta Parish

[1] *University of Western Australia*

Demonstrating the first positive-patterning process for creating passivated waveguides in porous silicon films using laser writing in a controllable atmosphere to retain an open pore structure suitable for highly sensitive optical sensor applications.

Poster session / **270**

Optimal mitigation of random-telegraph-noise dephasing by spectator-qubit

Author: Behnam Tonekaboni Faghihnasiri[1]

Co-authors: Areeya Chantasri [2]; Howard Wiseman [1]; Hongting Song [3]

[1] *Griffith University*

[2] *Mahidol University, Griffith University*

[3] *China Academy of Space Technology*

We develop optimal measurement and control strategies for spectator-qubits(SQ) to mitigate data-qubit dephasing caused by a random telegraph process. Our findings show that the SQ, like Dynamical Decoupling and Quantum Error Correction, may effectively increase the coherence of the data-qubit.

Conference on Optoelectronic and Microelectronic Materials and Devices / **271**

Two-dimensional materials for next-generation electronics, optoelectronics and antipathogenic coatings

Author: Sumeet Walia[1]

[1] *RMIT University*

Atomically-thin materials possess unique intrinsic properties and are amenable to a range of tuning techniques. We harness these properties underpinned by application demand and work with industry to translate into end-user products.

Poster session / **272**

An Interaction Quench Heat Engine Using a One-Dimensional Bose Gas

Author: Raymon Watson[None]

We theoretically investigate the performance of an interaction-driven many-body quantum heat engine with a working medium consisting of an experimentally realisable, harmonically trapped one-dimensional Bose gas, exploring the entire phase diagram.

Australian and New Zealand Conference on Optics and Photonics / **273**

Soliton linear-wave scattering and soliton multiplexing via bichromatic driving of a Kerr microresonator

Author: Pierce Qureshi[None]

Co-authors: Vincent Ng [1]; Farhan Azeem [2]; Luke Trainor [2]; Harald Schwefel [2]; Stephane Coen [1]; Miro Erkintalo [1]; Stuart Murdoch [1]

[1] *Department of Physics, University of Auckland, Auckland, New Zealand*

[2] *Department of Physics, University of Otago, Dunedin, New Zealand.*

We show in a Kerr microresonator the injection of a second laser, in addition to the pump laser, can facilitate useful spectral expansion of the original soliton comb. Furthermore we experimentally achieve excitation of two simultaneous solitons for spectroscopic applications.

7th International Workshop on Speciality Optical Fibres / 274

Efficient 2.8 μm Er3+-doped ZBLAN fiber laser pumped at 1.7 μm

Author: Junxiang Zhang[1]

Co-authors: Shijie Fu [1]; Quan Sheng [1]; Lu Zhang [1]; Wenxin Xia [1]; Wei Shi [1]; Jianquan Yao [1]

[1] *Tianjin University*

An efficient mid-infrared Er3+-doped fluoride fiber laser operating at 2.8 μm pumped by a single-mode laser at 1.7 μm has been proposed and experimentally demonstrated for the first time.

Precision and Quantum Sensing Workshop / 275

A practical quantum sensing wide-field probe for precision magnetic imaging

Author: Islay Robertson[1]

Co-authors: Alex Healey [2]; Gabriel Abrahams [1]; Jean-Philippe Tetienne [1]; Priya Singh [3]; Sam Scholten [2]

[1] *RMIT*

[2] *University of Melbourne*

[3] *RMIT University*

Widespread adoption of wide-field nitrogen-vacancy microscopy amongst the scientific community is hindered by non-trivial technical requirements. We demonstrate a method to overcome these challenges by developing a fully integrated diamond probe, and show some example applications.

AIP: Condensed Matter, Materials and Surface Physics / 276

Theory of emergent inductance in spiral magnets

Author: Daichi Kurebayashi[1]

Co-author: Oleg Tretiakov [1]

[1] *The University of New South Wales*

An analytic theory and micromagnetic approach have been developed for emergent inductors in spiral magnets, revealing what determines its inductance.

AIP: Relativity and Gravitation / **277**

Seismic-isolation-chain displacement sensing using Digital Interferometry

Author: Ya Zhang[1]

Co-authors: Bram Slagmolen [2]; Sheon Chua [1]

[1] *Australian National University*

[2] *The Australian National University*

Future interferometric gravitational-wave detectors are predicted to be impacted by low-frequency relative displacement motion between their seismic isolation platforms. We will present the advantages, sensitivity targets and latest prototype developments towards a digitally-enhanced interferometric sensor for measuring this motion.

Australian and New Zealand Conference on Optics and Photonics / **278**

Deactivation of NV- color centers in glass-sandwiched diamond particles

Authors: Andrew Greentree[1]; Brant Gibson[1]; David Simpson[2]; Heike Ebendorff-Heidepriem[None]; Marco Capelli[1]; Minh Hoa Huynh[3]; Philipp Reineck[1]; Scott Foster[4]; Shahraam Afshar Vahid[5]; Shou Li[1]; Wen Qi Zhang[5]

[1] *RMIT University*

[2] *The University of Melbourne School of Physics*

[3] *The University of Adelaide*

[4] *Defence Science and Technology Group*

[5] *University of South Australia*

Nitrogen-vacancy colour centres in diamonds have unique properties that attract significant attention for various applications. This work explores the deactivation of NV centres in diamond particles embedded in glass for an alternative fast sensor fabrication technique.

AIP: Group for Astroparticle Physics / Astronomy / **279**

Axion phenomenology in magnetized neutron stars

Author: Filippo Anzuini[1]

Co-authors: José A. Pons [2]; Antonio Gómez-Bañón [2]; Paul D. Lasky [1]; Federico Bianchini [3]; Andrew Melatos [4]

[1] *Monash University*

[2] *Universitat d'Alacant*

[3] *Stanford University*

[4] *The University of Melbourne*

The expectation value of the axion field in neutron stars becomes large due to finite density corrections. By comparing our magneto-thermal simulations with available neutron star data, we find new observable effects to constrain the axion parameter space.

Poster session / 280

Optical Tomographic Reconstruction of Objects within Diffuse Media

Author: Catherine Merx[1]

Co-authors: John Holdsworth [2]; Matthew Randall [1]; Galiya Sharafutdinova [1]

[1] *University of Newcastle*

[2] *ANZOS*

CCD array based detection of optical scatter has allowed tomographic reconstruction of objects immersed within scattering media. Encouraging results using the inverse Radon transform provide a basis for further investigation and improvement in detection of objects within diffuse media.

Poster session / 281

Nondegenerate internal squeezing: An all-optical, loss-resistant quantum technique for gravitational-wave detection

Author: James Gardner[None]

Co-authors: Bram Slagmolen ; David McClelland ; Min Jet Yap ; Sheon Chua ; Vaishali Adya

The detection of kilohertz-band gravitational waves promises discoveries in astrophysics, exotic matter, and cosmology. We study how to theoretically improve future interferometric gravitational-wave detectors' kilohertz-band sensitivity which is limited by quantum noise.

AIP: Nuclear and Particle Physics / 282

The Role of Vector Boson Fusion in the Production of Heavy Vector Triplets at the LHC and HL-LHC

Authors: Andrea Thamm[1]; Michael Baker[2]; Riccardo Torre[3]; Timothy Martonhelyi[1]

[1] *School of Physics, The University of Melbourne, Victoria 3010, Australia*

[2] *ARC Centre of Excellence for Dark Matter Particle Physics, School of Physics, The University of Melbourne, Victoria 3010, Australia*

[3] *INFN, Sezione di Genova, Via Dodecaneso 33, I-16146 Genova, Italy*

Pertaining to the analysis of heavy vector production at the LHC, this project focuses on vector boson fusion as the dominant production channel for heavy vector triplets and presents limits within the relevant parameter space.

Poster session / 283

Spontaneous high efficiency third harmonic generation in optical fibres

Authors: Shahraam Afshar Vahid[1]; Wen Qi Zhang[2]

[1] *Laser Physics and Photonic Devices Laboratories, University of South Australia, SA 5095, Australia*

[2] *University of South Australia*

Third (THG) and one-third harmonic generation (OTHG) have not been used practically despite their unique potential for various applications due to challenging phase matching conditions. Here we propose a stepladder scheme allowing efficient THG and OTHG from spontaneous processes.

AIP: Solar Terrestrial and Space Physics / 284

Poynting-Robertson stabilization of relativistic lightsails

Author: Rhys William Mackintosh[None]

Co-authors: Boris Timothy Alexis Kuhlmey [1]; Jadon Yunzheng Lin ; Michael Wheatland [1]

[1] *School of Physics, The University of Sydney*

We study the stability of laser driven light sails during acceleration by adapting the Poynting-Robertson Effect equations to generalised sail geometries, finding the existence of a passive damping force.

Poster session / 285

Size reduction of metallic nanoparticles during nanosecond pulsed z-scan experiments

Author: Joshua Davis[1]

Co-authors: Callum McArthur [1]; Esa Jaatinen [1]

[1] *Queensland University of Technology*

Highly local thermal effects which occur during a nanosecond laser pulse cause a significant change in the size distribution of metallic nanoparticles during a z-scan which can affect the z-scan results.

Poster session / **286**

Decode NFDM-QAM signals with carrier phase and frequency offsets using convolutional neural network

Authors: Shahraam Afshar Vahid[1]; Terence Chan[2]; Wen Qi Zhang[2]

[1] *Laser Physics and Photonic Devices Laboratories, University of South Australia, SA 5095, Australia*

[2] *University of South Australia*

This work explores the potential of convolutional neural network to directly decode information encoded in the nonlinear Fourier domain under the influence of carrier frequency offset and carrier phase offset.

AIP: Nuclear and Particle Physics / **287**

Intrinsic Background Characterisation of an Ultra-pure NaI test Crystal for SABRE South

Author: Ferdos Dastgiri[None]

This talk will present the characterisation methods and results of intrinsic backgrounds in an ultra-pure NaI crystal for the SABRE South dark matter experiment, with a focus on 238U and 232Th.

Poster session / **288**

Single and multilayer metal contacts for chemically and thermally robust interconnects to porous silicon-based sensors

Author: Pritam Sharma[None]

Co-authors: Gia Parish [1]; John Dell [1]; Adrian Keating [1]

[1] *University of Western Australia*

The choice of metal contacts on the surface of porous silicon films for fabricating opto-electronic devices is affected by post-metal deposition processing steps. In the present work, Al, Cr/Au, Ti, and Ti/Pt/Au metallisation schemes were investigated for fabricating such devices.

AIP: Theoretical and Mathematical / **289**

A possibilistic no-go theorem on the Wigner's friend paradox

Authors: Eric G. Cavalcanti[1]; Marwan Haddara[1]

[1] *Centre for Quantum Dynamics, Griffith University, Gold Coast, Queensland 4222, Australia*

We demonstrate a logical no-go theorem on a version of the Wigner's friend thought experiment which strengthens previous device-independent no-go results and opens new questions on the interface of quantum foundations and modal logic.

Australian and New Zealand Conference on Optics and Photonics / 290

Mode-locked Fibre Lasers in the Mid-Infrared Region

Author: Claude Aguegaray[1]

Co-authors: B. Dutta Gupta [1]; Ian Hendry [1]; M. Erkintalo [1]; S. Tang [1]

[1] *The University of Auckland*

In this work, we aim to experimentally generate supercontinua in the mid-infrared region using the novel architecture of nonlinear amplification. This work is guided by simulations that utilize recently developed numerical models.

7th International Workshop on Speciality Optical Fibres / 291

Fibre-based Optomechanical Acoustic Sensing

Author: Lauren McQueen[None]

Co-authors: Glen Harris [1]; Warwick Bowen [2]

[1] *University of Queensland*

[2] *The University of Queensland*

I will outline recent work towards developing a nanometer sized acoustic sensor based on 1D photonic crystals, which can be used for fibre-based optomechanical acoustic sensing.

Poster session / 292

Ultrastable dual frequency comb generation using whispering gallery resonators

Author: Nicholas Lambert[1]

Co-authors: Harald Schwefel [2]; Luke Trainor [2]

[1] *University of Otago*

[2] *Department of Physics, University of Otago, Dunedin, New Zealand.*

We use a lithium niobate whispering gallery mode resonator embedded in a microwave cavity to efficiently generate a dual frequency comb. Judicious use of crystal symmetries leads to our two combs being orthogonally polarized, and they are ultrastable in frequency.

Poster session / 293

Development of a glass-based imaging phantom to model the optical properties of human tissue

Author: Mingze Yang[1]

Co-authors: Rob McLaughlin [2]; Yunle Wei [1]; Philipp Reineck [3]; Heike Ebendorff-Heidepriem [4]; Jiawen Li [2]

[1] *The University of Adelaide*

[2] *University of Adelaide*

[3] *School of Science, RMIT University, Melbourne, VIC 3001, Australia*

[4] *H. Ebendorff-Heidepriem*

We present a novel design of optical phantom using metal-ion doped glass-ceramics. Comprising crystalline structure and nickel ion in the glass matrix, this glass-based optical phantom can mimic the optical properties of human tissues with excellent optical homogeneity and stability.

7th International Workshop on Speciality Optical Fibres / 294

3D printing Bullseye glass preform for fibre drawing

Authors: Anna Radionova[1]; Erik Schartner[1]; Heike Ebendorff-Heidepriem[None]; Meike Denker[2]; Tony Koutsonikolas[3]; Xuanzhao Pan[4]; Yunle Wei[5]

[1] *Institute for Photonics and Advanced Sensing (IPAS) & School of Physical Sciences, The University of Adelaide, Adelaide 5005, SA, Australia*

[2] *Institute for Machine Elements, Design and Manufacturing, Freiberg, Germany*

[3] *Maple Glass Printing Pty Ltd, Melbourne, VIC, 3070, Australia*

[4] *School of Physical Sciences, The University of Adelaide, Adelaide, SA, 5005, Australia*

[5] *The University of Adelaide*

Additive manufacturing makes it possible to produce complex structures and individual pieces directly from the CAD file within short production times. This research focuses on a filament extrusion method, where the objects are directly printed from a soda-lime glass filament.

Poster session / 295

Measurement of B0 –> D-pi+pi0 at the Belle Experiment

Author: Kim Smith[None]

Co-author: Martin Sevior [1]

[1] *University of Melbourne*

This analysis uses the Belle dataset consisting of 620×10^6 B meson pairs and includes a first measurement of the branching fraction and helicity angle asymmetry of $B^0 \to D^- \pi^+ \pi^0$ as well as an update to the branching fraction of $B^0 \to D^- \rho^+$.

AIP: Quantum Science and Technology / 296

Quantum mean states are nicer than you think: finding states maximizing average fidelity

Author: Christopher Ferrie[1]

Co-authors: A Afham [2]; Richard Kueng [3]

[1] *Center for Quantum Software and Information, University of Technology Sydney*

[2] *PhD student, Center for Quantum Software and Information, University of Technology Sydney.*

[3] *Johannes Kepler University Linz*

We compute states that maximize average fidelity over ensembles of quantum states via semidefinite programs. We derive lower and upper bounds to maximal average fidelity that are exact in the commuting scenario. Our results find applications in tomography.

Poster session / **297**

On Demand Formation of Polar Core Vortices in Ferromagnetic Spinor Bose Einstein Condensates

Author: Zachary Kerr[1]

Co-authors: Guillaume Gauthier [1]; Halina Rubinsztein-Dunlop [1]; Matthew Davis [1]; Tyler Neely [1]

[1] *The University of Queensland*

We describe our efforts to realise on-demand PCV creation in quasi-2D 87Rb spinor BEC with uniform density, created in an optical trap enabled by digital-micromirror devices (DMDs).

AIP: Nuclear and Particle Physics / **298**

Mapping the 3D structure of hadrons with lattice quantum chromodynamics

Authors: Alec Hannaford Gunn[1]; James Zanotti[1]; K. Utku Can[1]; Ross Young[None]

[1] *The University of Adelaide*

A presentation of our recent work to determine the 3D structure of hadrons using lattice quantum chromodynamics. This work complements forthcoming experiments at the Brookhaven Electron-Ion Collider.

Conference on Optoelectronic and Microelectronic Materials and Devices / **299**

Defining & Optimising Chaos Bandwidth - Semiconductor Laser Systems

Author: Deb Kane[None]

Co-author: Mindaugas Radziunas [1]

[1] *Weierstrass Institute, Leibniz Institute in Forschungsverbund*

Optimum semiconductor laser parameters for generating broad rf bandwidth chaotic output are informed by numerical simulation results of a SL with delayed optical feedback system. The simulation results are also connected with experiments.

AIP: Nuclear and Particle Physics / **300**

Sensitivity of the SABRE Experiment to WIMP Signals and Seasonal Backgrounds

Author: Kyle Leaver[1]

[1] *University of Adelaide*

This work examines the sensitivity of the upcoming SABRE South experiment to the annual modulation dark matter signal. We also consider the effect of a hemisphere-dependent seasonal background on direct detection experiments.

AIP: Group for Astroparticle Physics / **Astronomy** / **301**

Recent results in TeV gamma-ray astronomy with H.E.S.S.

Author: Gavin Rowell[None]

The High Energy Stereoscopic System has revolutionised TeV gamma-ray astronomy over the past two decades. This presentation will highlight some of the recent discoveries from H.E.S.S. over the past year or so (such as novae, gamma-ray bursts and pulsars).

Poster session / **302**

Magnetic Monopole Response for an Electric Charge Near Multilayer Composites with Topological Insulator

Authors: Benjamin Pavez[1]; Brant C Gibson[2]; Eitan Dvorquez[1]; Jero R. Maze[1]; Qiang Sun[3]; Andrew Greentree[4]

[1] *Institute of Physics, Pontificia, Universidad Católica de Chile, Santiago, Chile*

[2] *ARC Centre of Excellence for Nanoscale Biophotonics, School of Science, RMIT University, Melbourne, Victoria 3000, Australia*

[3] *Australian Research Council Centre of Excellence for Nanoscale BioPhotonics, School of Science, RMIT University, Melbourne, VIC 3001, Australia*

[4] *RMIT University*

One key challenge in the search for new Topological Insulators (TI) is their characterization. Through theoretical modelling, we identify a method to improve the magnetic monopole response of TI which can be used to rapidly characterize the properties of TIs.

AIP: Nuclear and Particle Physics / **303**

Radio Frequency Breakdown Analysis at CERN's High Gradient Test Stands: a Machine Learning approach

Author: Paarangat Pushkarna[1]

Co-authors: Matteo Volpi [2]; Rebecca Auchettl [1]

[1] *The University of Melbourne*

[2] *The Melbourne University*

Shortcomings of Machine Learning methods for Breakdown prediction in High Gradient, Radio Frequency linear accelerating cavities have been identified. We consider improvements upon existing techniques to improve understanding of Breakdown phenomena, in collaboration with CERN.

Australian and New Zealand Conference on Optics and Photonics / 304

Broadband Frequency Combs in Photonic-Belt Resonators

Author: Vincent Ng[1]

Co-authors: Farhan Azeem [2]; Harald Schwefel [2]; Luke Trainor [2]; Miro Erkintalo [1]; Pierce Qureshi ; Stephane Coen [1]; Stuart Murdoch [1]

[1] *University of Auckland*

[2] *University of Otago*

We consider frequency comb generation in high-finesse magnesium fluoride photonic belt resonators. The confinement to a few spatial modes permits comb excitation free from linear mode interactions. The comb was extended via a dispersive wave, resulting in a broadband spectra.

7th International Workshop on Speciality Optical Fibres / 306

Characterisation of Erbium-Doped DFB Lasers Pumped Resonantly at 1480 – 1540 nm

Author: Nikita Simakov[1]

[1] *DSTG*

Energising and interrogating distributed feedback fibre laser hydrophones in remote deployment scenarios requires management of the propagation loss, optical nonlinearity and judicious selection of the pump wavelength. We characterise the system for a range of pump wavelengths spanning from 1480-1540nm.

AIP: Atomic and Molecular Physics / 307

Attosecond delays of high harmonic emissions from isotopes of molecular hydrogen measured by Gouy phase XUV interferometer

Author: Igor Litvinyuk[None]

We present precise measurement of HHG phase difference between two isotopes of molecular hydrogen using advanced Gouy phase interferometer. The measured phase difference is about 200 mrad, corresponding to ~3 attoseconds time delay which is nearly independent of harmonic order.

AIP: Nuclear and Particle Physics / 308

Studying the role of multi-parton interactions in the production of doubly-heavy hadrons in proton-proton collisions

Author: Tom Hadavizadeh[1]

Co-authors: Eliot Jane Walton [1]; Mika Anton Vesterinen [2]; Minni Singla [1]; Peter Skands [1]; Ulrik Egede [1]

[1] *Monash University (AU)*

[2] *University of Warwick (GB)*

The beauty and charm quarks are ideal probes of perturbative Quantum Chromodynamics, owing to their large masses. The formation of hadrons from quarks produced in different parton-parton interactions within the same proton-proton collision is studied using doubly-heavy hadrons.

Joint session: AIP-BMP / COMMAD / 310

Modelling laser interaction with retinal tissue at the cellular level

Author: Linh Thai Dieu Truong[1]

Co-authors: A. Bruce Wedding [1]; Peter Lesniewski [1]

[1] *University of South Australia*

This work explores the feasibility of simulating heat transfer for a single laser irradiated retinal cell in 3D, with a focus on a novel methodology to represent laser intensity decay for complex structures with sub-micron resolution.

AIP: Group for Astroparticle Physics / Astronomy / 311

The TeV Diffuse Gamma-ray Emission: Time Variability and Prospects for Future Detection

Author: Gavin Rowell[None]

Co-authors: Gudlaugur Johannesson ; Peter Marinos [1]; Troy Porter [2]

[1] *The University of Adelaide*

[2] *Stanford University*

We use the simulation software "GALPROP" to model the Milky Way's diffuse TeV gamma-ray emission. We compare GALPROP's predictions to observational data, investigating how the emission will impact the forthcoming CTA Observatory's Milky Way survey.

AIP: Atomic and Molecular Physics / 312

Rapid production of metastable helium BEC using cross-beam dipole trap

Authors: Abbas Abbas[1]; Andrew Truscott[None]; Jacob Ross[None]; Rohit Patil[1]; Sam Meng[1]; Sean Hodgman[None]

[1] *Australian National University*

We demonstrate the laser cooling techniques for rapid production of a metastable helium BEC. The experimental setup features an in-vacuum magnetic trap and a cross-beam optical dipole trap. We obtained a pure BEC of 1 million atoms in 3.3 seconds.

Poster session / **314**

Quantum Rabi model with PT-symmetry

Authors: Xilin Lu[None]; Zi-Min Li[1]

[1] *Central South University*

Construct the $\mathcal{PT}$-symmetric QRM, derive the spectrum and investigate the $\mathcal{PT}$-phase boundaries (as exceptional surfaces) at different parameter regimes.

AIP: Atomic and Molecular Physics / **315**

Machine learning optimised stirring of persistent currents in BECs

Author: Simeon Simjanovski[1]

Co-authors: Guillaume Gauthier [1]; Halina Rubinsztein-Dunlop [1]; Matthew Davis [1]; Tyler Neely [1]

[1] *The University of Queensland*

We apply machine learning methods to control and optimise the stirring protocol imposed on Rubidium-87 Bose-Einstein condensates in experiment. The optimisation allows for controlled generation of various persistent current states albeit with no universal optimum stirring parameters.

Poster session / **316**

Consequences of dark neutron decay inside neutron stars

Author: Wasif Husain[1]

[1] *The University of Adelaide*

N.A

AIP: Nuclear and Particle Physics / **317**

The Compton amplitude and structure functions of the nucleon

Author: K. Utku Can[1]

[1] *The University of Adelaide*

I focus on the QCDSF/UKQCD/CSSM lattice collaboration's advances in calculating the forward Compton amplitude of nucleon via an implementation of the second-order Feynman-Hellmann theorem. I highlight our progress on investigating the low moments of (un)polarised structure functions of the nucleon.

AIP: Atomic and Molecular Physics / 318

Experimental investigations of positron-molecule scattering resonances

Authors: David Stevens[None]; James Sullivan[None]; Zoe Cheong[None]

Submission for oral presentation

Joint session: AIP-BMP / COMMAD / 319

Nitrogen-doped ultrananocrystalline diamond electrodes for photostimulation of human mesenchymal stem cells

Author: Andre Chambers[1]

Co-authors: Amy Gelmi [2]; Arman Ahnood [3]; Hassan Al Hashem [3]; James Collins [3]

[1] *School of Physics, The University of Melbourne*

[2] *School of Science, RMIT University*

[3] *School of Engineering, RMIT University*

In this work, nitrogen-doped ultrananocrystalline diamond (N-UNCD) electrodes are characterised for light-based cell stimulation. We utilise ultraviolet photoelectron spectroscopy (UPS) to probe the photocurrent mechanisms of these photoelectrodes, which are then applied for the stimulation of human mesenchymal stem cells.

Poster session / 320

All Optical Initialisation and Readout and Coherent Population Trapping of a Single Germanium Vacancy in Diamond

Author: Chris Adambukulam[1]

Co-authors: Andrea Morello [1]; Arne Laucht [1]; Brett C. Johnson [2]; Hyma H. Vallabhapurapu [1]

[1] *University of New South Wales*

[2] *Royal Melbourne Institute of Technology*

We demonstrate the capability to address the spin sub-levels of the germanium vacancy and thus, perform all optical spin initialisation and readout. Additionally, we generate dark coherent superpositions of the germanium vacancy spin states through coherent population trapping.

Poster session / **321**

60 Years of the Australian Institute of Physics

Author: Stephen Collins[None]

Membership trends and related statistics of the Australian Institute of Physics over the 60 years since its establishment in 1963 are presented. Its Members have had distinguished careers in universities, research organisations or industry.

Poster session / **324**

A Rubidium Cold Focussed Ion Beam

Author: Kaih Mitchell[None]

We present a laser-cooled rubidium focussed ion beam for use in nano-fabrication and imaging. We aim to achieve higher beam brightness and smaller focus spot sizes than gallium focussed ion beams.

AIP: Atomic and Molecular Physics / **325**

Calculations of positron scattering from atomic carbon

Author: Nicolas Mori[None]

Co-authors: Dmitry Fursa [1]; Igor Bray [1]; Liam Scarlett [1]

[1] *Curtin University*

We have extended the single-centre CCC to allow application to atoms with any number of electrons. We have addressed deficits in this method using a complex model potential calculation. Using this new approach we have completed positron carbon scattering calculations.

Poster session / **326**

Distributed Quantum Computation on Continental Scales Operates on Kilohertz Clock Cycle with Quantum Satellite Networks

Author: Hudson Leone[1]

Co-authors: Simon Devitt [1]; Srikara Shankara

[1] *UTS*

In this paper, we demonstrate that the rate at which logical Bell states can be generated between distant fault-tolerant quantum computers is on the order of 1KHZ. This imposes a hard limit on the distributed clock speed.

Poster session / **327**

Radiotherapy LINAC Breakdowns in Low- and Middle-Income Countries

Authors: Gregory Peiris[1]; Muhammad Kasim[2]; Supriyanto Pawiro[3]; Suzanne Sheehy[2]

[1] *The University of Melbourne*

[2] *The University of Oxford*

[3] *Universitas Indonesia*

Radiotherapy treatment in Low- and Middle-Income Countries is under significant strain due to environmental, socio-economic and geographic factors which cause Linear Accelerators used in treatment to breakdown. This study aims to quantify the problem and provide robust alternatives.

Poster session / **328**

Feasibility of Quantum Support Vector Machines for classification problems in Particle Physics

Author: Jamie Heredge[None]

Co-authors: Charles Hill [1]; Lloyd Hollenberg [1]; Martin Sevior [1]

[1] *The University of Melbourne*

Our previously implemented quantum support vector machine outperformed standard classical methods for B Meson classification (using reduced dataset). In this work we will explore the feasibility of application to particle physics showing alternative encoding methods and speedups.

AIP: Quantum Science and Technology / **330**

Point Exchange Invariant and Automatically Generated Feature Maps in Quantum Support Vector Machines for Practical Applications

Author: Jamie Heredge[None]

Co-authors: Charles Hill [1]; Lloyd Hollenberg [1]; Martin Sevior [1]

[1] *The University of Melbourne*

Inspired by 3D imagining problems we investigate methods of quantum encodings that are invariant to permutations of points in the original input for collections of 3D points (point cloud) data, within the context of a particle physics application.

AIP: Quantum Science and Technology / **331**

Deterministic ion implantation of donor spin qubits

Author: Danielle Holmes[1]

Co-authors: Alexander Jakob [2]; Andrea Morello [1]; David Jamieson [2]; Simon Robson [2]; Vincent Mourik [1]

[1] *UNSW, Sydney*

[2] *The University of Melbourne*

The deterministic implantation of single donors in silicon is realised using ion beam induced charge detectors. This will enable the fabrication of arrays of donor spin qubits, required to scale up the promising quantum computing platform of donors in silicon.

AIP: Theoretical and Mathematical / 332

Radiofrequency response and thermodynamic properties of the Fermi polaron

Authors: Weizhe Liu[None]; Haydn Adlong[None]; Zheyu Shi[None]; Meera Parish[1]; Jesper Levinsen[1]

[1] *Monash University*

The Fermi polaron, a particle dressed by excitations of a fermionic medium, is a problem that arises in multiple contexts. I will discuss recent theory progress toward understanding the static and dynamic properties of such polarons in ultracold Fermi gases.

Australian and New Zealand Conference on Optics and Photonics / 333

Electrical Control of Single Photon Emitters in Hexagonal Boron Nitride

Authors: Alastair Stacey[1]; Chi Li[2]; I. Aharonovich[3]; M. Kianinia[3]; Milos Toth[2]; Nikolai Dontschuk[4]; Simon White[2]; Tieshan Yang[2]; Zai-Quan Xu[2]

[1] *RMIT University*

[2] *School of Mathematical and Physical Sciences, University of Technology Sydney, Ultimo, New South Wales 2007, Australia.*

[3] *School of Mathematical and Physical Sciences, University of Technology Sydney, Ultimo, NSW 2007, Australia*

[4] *The University of Melbourne School of Physics*

The control and manipulation of quantum systems underpin the development of scalable quantum technologies. Here, we demonstrate the electrical activation and modulation of single photon photoluminescence from quantum emitters in hexagonal boron nitride.

Poster session / 335

Phase-space simulations of Gaussian Boson Sampling quantum networks

Author: Alexander Dellios[None]

Co-authors: Bogdan Opanchuk [1]; Margaret Reid [1]; Peter Drummond [1]

[1] *Swinburne University of Technology*

We show how one can use phase-space represenations of quantum mechanics to compare theoretical and experimental outputs of linear bosonic networks. These methods are applied to data from recent large scale experiments of a Gaussian Boson Sampling quantum computer.

AIP: Solar Terrestrial and Space Physics / 336

Doppler perturbations of satellite observations by VHF ST radar

Author: Jordan Jonker[1]

Co-authors: Andrew MacKinnon ; David Holdsworth ; David Neudegg ; Iain Reid ; Manuel Cervera ; trevor harris [1]

[1] *University of Adelaide*

The University of Adelaide's Buckland Park VHF radar site has observed unexpected perturbations in measurements of a satellite's radial velocity (Doppler). Fourier analysis and an algorithm have been applied to the data to link the perturbations to recorded ionospheric disturbances.

Poster session / 337

Optical access of Er in Si with 0.5 ms electron spin coherence times

Author: Ian Berkman[1]

Co-authors: Alexey Lyasota [1]; Bin-Bin Xu [1]; Brett C. Johnson [2]; Chunming Yin [3]; Gabriele G. De Boo [1]; Jeffrey C. McCallum [4]; John G. Bartholomew [5]; Matthew J. Sellars [6]; Rose L. Ahlefeldt [6]; Shouyi Xie [1]; Sven Rogge [1]

[1] *The University of New South Wales*

[2] *Royal Melbourne Institute of Technology*

[3] *The University of Science and Technology of China*

[4] *The University of Melbourne*

[5] *The University of Sydney*

[6] *The Australian National University*

Using a sample-on-SSPD approach, we demonstrate optically accessible Er sites in Si with emission at telecom wavelengths. These sites contain electron spins with a coherence time of 0.5 ms and Rabi frequencies of over 1 MHz.

Poster session / 338

Defining the Quantum Mechanical Time Observable

Author: Khai Bordon[1]

Co-authors: Fatema Tanjia [1]; Joan Vaccaro [1]

[1] *Griffith University - Centre for Quantum Dynamics*

Time in its current state is discussed without reference to an operator that represents the time observable, the aim of this work is to rectify this and investigate how such an observable can be represented.

AIP: Nuclear and Particle Physics / 339

VISHν: a unified solution to five SM shortcomings with a protected electroweak scale

Author: Alexei Sopov[1]

Co-author: Raymond Volkas

[1] *University of Melbourne*

We propose a variant-axion extension of the Standard Model (coined VISHν) which additionally explains small neutrino masses, dark matter, the baryon asymmetry of the universe and inflation, while remaining technically natural and cosmologically benign.

Poster session / 340

QED radiative corrections to E1 amplitudes in heavy atoms

Author: Carter Fairhall[1]

Co-authors: Benjamin Roberts [1]; Jacinda Ginges

[1] *The University of Queensland*

We use the radiative potential method to report on the first detailed study of the interplay between QED and many-body effects in heavy atoms for E1 transition amplitudes.

Poster session / 341

Impact of the Purcell and Spontaneous Emission Factors in Nanowire Lasers

Author: Parya Reyhanian[1]

Co-authors: Arti Agrawal [2]; Charlene Lobo [3]; Christopher Poulton [4]

[1] *Student*

[2] *Adjunct Associate Professor*

[3] *Associate Professor*

[4] *Professor*

We present a numerical estimation of spontaneous emission factor for multiple quantum disks embedded in nanowire lasers and, investigate the impact of Purcell effect F and spontaneous emission factor β on the threshold and the L-L curves.

Poster session / **342**

Interpretation of Dirac Fermions as a Four-Dimensional Gaussian

Author: Ayden Howarth[1]

Co-authors: Fatema Tanjia [1]; Joan Vaccaro [1]

[1] *Griffith University*

We reinterpret internal degrees of freedom of a Dirac fermion as a local wavefunction oriented in 4D spacetime. This is done beginning with two 2D spinors, using the quantum theory of time as well as spherical harmonics.

AIP: Theoretical and Mathematical / **343**

Grassmann Phase Space Theory for the BEC/BCS Crossover in Cold Fermionic Atomic Gases

Author: Bryan Dalton[1]

[1] *Swinburne University of Technology*

Grassmann Phase Space Theory is applied to the BEC/BCS crossover in cold fermionic atomic gases to determinine the time/temperature evolution of Quantum Correlation Functions specifying the positions of fermionic atoms of opposite spin in single or two Cooper pairs.

Poster session / **344**

Fluctuation theorem in non-equilibrium vortex systems

Author: Rama Sharma[1]

[1] *Optical Sciences Centre, Swinburne University of Technology, Melbourne, Australia*

We want to analyse the fluctuation theorem in the context of a two-dimensional vortex matter system.

7th International Workshop on Speciality Optical Fibres / **345**

Efficient third harmonic generation: phase compensation using inter-fibre spacing

Author: Zane Peterkovic[None]

Co-authors: Shahraam Afshar Vahid [1]; Stephen Warren-Smith ; Wen Qi Zhang [2]

[1] *Laser Physics and Photonic Devices Laboratories, University of South Australia, SA 5095, Australia*

[2] *University of South Australia*

Herein we present a scheme for highly efficient third harmonic generation (THG) via a phase compensation between two segments of fibre; we simulate the gap between these segments to characterise the coupling, gap length, and effects of misalignment.

AIP: Atomic and Molecular Physics / 346

Accurate determination of the magnetic hyperfine anomaly in atomic cesium from muonic-atom experiments

Author: George Sanamyan[None]

Co-authors: Benjamin Roberts ; Jacinda Ginges

We have used a combination of muonic-atom and atomic many-body calculations to extract magnetic hyperfine anomaly in caesium atom from muonic cesium measurements. Our result is important for cesium atomic parity violation studies.

AIP: Quantum Science and Technology / 347

The bound-hole state of the NV- center in diamond

Author: YunHeng Chen[1]

[1] *Australian National University*

In this work, we introduce a semi-ab initio method for modelling the bound-hole states of the negatively-charged NV center (NV-). Our semi-ab initio approach can be readily adapted to other deep defects in semiconductors.

AIP: Nuclear and Particle Physics / 349

Impact of dynamical fermions on the centre-vortex structure of QCD ground-state fields

Author: Derek Leinweber[1]

Co-authors: James Biddle [2]; Waseem Kamleh [2]; Adam Virgili [2]

[1] *CSSM, University of Adelaide*

[2] *University of Adelaide*

Using modern visualisation techniques, this presentation examines the structure of centre vortices in the nontrivial ground-state fields of QCD. Their link to the generation of mass and the confinement of quarks is explored.

AIP: Atomic and Molecular Physics / 350

New optical clocks based on Cu II, Yb III, Hf II, Hf IV, and W VI ions which may be used to search for dark matter and variation of the fine structure constant

Author: Saleh Allehabi[None]

Co-authors: Victor Flambaum [1]; Vladimir Dzuba [2]

[1] *University of New South Wales*

[2] *UNSW*

- Study metastable excited states for these ions as clock transitions in optical clocks.
- Calculating several atomic properties.
- CI+SD and CIPT methods are used.
- Black body radiation (BBR) found 10^-16-10^-18.
- The enhancement coefficient reached K= 8.3.

Precision and Quantum Sensing Workshop / 351

Einstein–Podolsky–Rosen Entangled Interferometers

Author: Daniel Gould[1]

Co-authors: Bram Slagmolen [2]; David McClelland ; Dennis Wilken [3]; Michèle Heurs [3]; Min Jet Yap ; Robert Ward ; Vaishali Adya

[1] *Australian National University*

[2] *The Australian National University*

[3] *Max Planck Institute for Gravitational Physics, Albert Einstein Institute, Hannover*

Detectors designed to investigate fundamental physics such as quantum gravity and gravitational waves have been proposed utilising twin interferometers. We aim to demonstrate the improvement of a twin interferometer experiment via injecting Einstein-Podolsky-Rosen squeezed states.

Precision and Quantum Sensing Workshop / 352

Vector Magnetometry Using Nitrogen-vacancy Centers in Diamond

Author: Chris Lew[None]

In this talk, we present our approach toward the establishment of a full vector magnetometer using the nitrogen-vacancy defect center in diamond.

Poster session / 353

Electrical Detection of Coherent Spin States in a Silicon Carbide Device

Author: Chris Lew[None]

We present our recent results on the electrical detection of coherent spin manipulation of spin-dependent recombination in a silicon carbide pn-junction device at room temperature via pulsed electrically detected magnetic resonance.

Poster session / **354**

Diffuse Scattering Studies from a Martensitic Fe-Pd Alloy

Author: Trevor Finlayson[1]

Co-authors: Garry J. McIntyre Garry J. McIntyre [2]; Kirrily Rule [2]

[1] *University of Melbourne*

[2] *ANSTO*

Results from the Koala, Taipan and Sika instruments at the OPAL reactor, ANSTO, reveal two martensitic transformations for an Fe-30at%Pd crystal between 400 to 100K. These results will be discussed in this poster presentation.

AIP: Biomedical and Medical Physics / **355**

Tracking the nuclear wide dynamics of live cell nucleosome proximity by fluorescence anisotropy imaging of histone FRET

Authors: Alex Hopper[1]; Ashleigh Solano[1]; Elizabeth Hinde[1]

[1] *University of Melbourne*

Here we present a powerful new microscopy method based on fluorescence anisotropy imaging microscopy (FAIM) of Förster resonance energy transfer (FRET) between fluorescently labelled nucleosomes to spatiotemporally map live cell genome organisation in real time with super resolution.

Precision and Quantum Sensing Workshop / **357**

Diamond-doped Optical Fibres for Remote Magnetometry Applications

Authors: Marco Capelli[1]; Dongbi Bai[1]; Hoa Huynh[2]; Shuo Li[1]; Wenqi Zhang[3]; Philipp Reineck[1]; David Simpson[4]; Shahraam Afshar.V[3]; Andrew Greentree[1]; Scott Foster[5]; Heike Ebendorff-Heidepriem[2]; Brant Gibson[None]

[1] *RMIT University*

[2] *The University of Adelaide*

[3] *University of South Australia*

[4] *The University of Melbourne*

[5] *Defence Science and Technology Group*

The ability to monitor weak magnetic fields is a key objective in long-term surveillance. Here I will discuss the fabrication and characterization of an intrinsically magneto-sensitive diamond doped optical fibre with potential applications as a high-efficiency remote magnetic sensing platform.

Poster session / **358**

Optical Limiting and Transient Grating in VO2 Thin Multilayers

Authors: Dragomir Neshev[1]; Rocio Camacho[1]

Co-authors: Andrea Tognazzi [2]; Bohan Li [1]; Gina Ambrosio [3]; Paolo Franceschini [4]; camilla baratto [4]; Domenico de Ceglia [3]; Alfonso Carmelo Cino [2]; Costantino De Angelis [3]; Marco Gandolfi [3]

[1] *The Australian National University*

[2] *University of Palermo*

[3] *Università degli studi di Brescia and CNR-INO*

[4] *CNR-INO*

We propose a planar device featuring vanadium dioxide (a phase change material) for optical limiting purposes. We first characterize the static and dynamic response with numerical simulations and finally we verify the performances with experiments.

Poster session / **359**

Fluorescent nanodiamonds have disk-like shapes: implications for nanodiamond engineering and quantum sensing applications

Authors: Samir Eldemrdash[None]; Giannis Thalassinos[None]; Qiang Sun[1]; Ella Walsh[None]; Tamar Greaves[1]; Erin Grant[2]; Hiroshi Abe[None]; Takeshi Ohshima[None]; Petr Cigler[None]; Pavel Matejicek[None]; Andrew Greentree[1]; David Simpson[None]; Gary Bryant[None]; Brant Gibson[None]; Philipp Reineck[None]

[1] *RMIT University*

[2] *Uni Melbourne*

Fluorescent nanodiamonds (FNDs) made from HPHT diamond have predominantly disk-like shapes. A typical FND is three times wider (eg in x-y) than it is thick (eg in z). This has important implications for the next generation of nanodiamond-based quantum sensors.

Poster session / **360**

Visible to Short-Wave Infrared Photodetectors Based on the van der Waals Material ZrGeTe4

Author: Wei Yan[1]

[1] *The University of Melbourne*

The self-terminated, layered structure of van der Waals materials introduces fundamental advantages for IR optoelectronic devices. We introduce a new van der Waals material candidate, zirconium germanium telluride (ZrGeTe4), to a growing family of promising IR van der Waals materials.

Conference on Optoelectronic and Microelectronic Materials and Devices / 362

MBE growth and mechanical properties of HgCdSe infrared materials

Author: Shuo Ma[None]

Co-authors: Lorenzo Faraone [1]; Mariusz Martyniuk [1]; Wen Lei [1]; Wenwu Pan [1]; Zekai Zhang

[1] *The University of Western Australia*

We report high-quality MBE growth and a mechanical property study of HgCdSe layers on GaSb (211) substrates. Both the crystal quality and the mechanical properties of HgCdSe have been demonstrated to be comparable to those of HgCdTe

Australian and New Zealand Conference on Optics and Photonics / 363

Diamond-glass nanoparticles for nanoscale quantum sensing

Authors: Andrew Greentree[1]; Brant C. Gibson[2]; Heike Ebendorff-Heidepriem[None]; Philip R. Hemmer[3]; Philipp Reineck[4]; Qiang Sun[None]

[1] *RMIT University*

[2] *Australian Research Council Centre of Excellence for Nanoscale Biophotonics, RMIT University*

[3] *Department of Electrical and Computer Engineering, Texas A&M University, College Station, Texas 77843, U.S.A.*

[4] *School of Science, RMIT University, Melbourne, VIC 3001, Australia*

We model the effects of coating nanodiamonds with glass, to mitigate some of the particle-to-particle variability with as-received nanodiamonds by creating a more uniform spherical shape. Such new particles represent a new platform for multi-function quantum biosensing.

Poster session / 364

Field-Effect Transistor Device based on Liquid-Metal-Printed Silver-Doped Indium Oxide

Author: Shirui Zhang[1]

Co-authors: Azmira Jannat ; Rob Elliman [2]

[1] *Australian National University*

[2] *Department of Electronic Materials Engineering, Research School of Physics, The Australian National University*

Faced with the down-scaling of semiconductor devices and the rapid development of 2D materials-based field-effect transistors, we report on the synthesis and properties of ultrathin silver-doped indium oxide nanosheets fabricated using a simple liquid-printing process for application of semiconducting channel

AIP: Quantum Science and Technology / 365

Low Depth Parity Check Gate set for Quantum Error Correction

Author: GOZDE USTUN[1]

Co-authors: Andrea Morello [2]; Simon Devitt [3]

[1] *UNSW*

[2] *University of New South Wales*

[3] *UTS*

We build low depth parity check gate set such that these gates become the most natural gate for QEC implementation.By building gates that are fundamental to QEC rather than universal computation,we can boost the threshold and ease the experimental hardness.

Poster session / 366

Recovering quantum metrology advantage in the presence of noise

Author: Nattaphong Wonglakhon[1]

Co-author: Gerardo Paz-Silva [1]

[1] *Griffith University*

In quantum metrology in the presence of noise, we show that using multi axis control leads to better than SQL scaling, and can even recover Heisenberg scaling under appropriate conditions.

Conference on Optoelectronic and Microelectronic Materials and Devices / 368

High performance HgCdTe Infrared Photodetectors for Sensing Applications

Author: Nima Dehdashti[1]

Co-authors: Gilberto A. Umana-Membreno [1]; Jarek Antoszewski [1]; Lorenzo Faraone [1]; Renjie Gu [1]

[1] *University of Western Australia*

We present high performance HgCdTe infrared photodetectors for sensing applications in the mid-wave spectral band of 3~5 μm based on the n-on-p technology.

AIP: Atomic and Molecular Physics / 369

Mutual friction and diffusion of two-dimensional quantum vortices

Author: Zain Mehdi[1]

Co-authors: Ashton Bradley [2]; Joseph Hope [1]; Stuart Szigeti [1]

[1] *The Australian National University*

[2] *University of Otago*

We present a microscopic theory of thermally-damped vortex motion in oblate atomic superfluids, providing a microscopic origin for the damping and Brownian motion of quantized vortices in two-dimensional atomic superfluids, which has previously been limited to phenomenology.

Poster session / **370**

Efficient Frequency doubling in LNOI Waveguides using Bounded State in Continuum

Author: Andreas Boes[1]

Co-authors: Thach G Nguyen [2]; Shankar K Selvaraja [3]; Arnan Mitchell [4]; Jackson Jacob Chakkoria [5]

[1] *University of Adelaide; RMIT University*

[2] *1. School of Engineering, RMIT University, Melbourne, VIC 3001, Australia.*

[3] *2. Centre for Nano Science and Engineering, Indian Institute of Science, Bangalore, India*

[4] *1. School of Engineering, RMIT University, Melbourne, VIC 3001, Australia*

[5] *1. School of Engineering, RMIT University, Melbourne, VIC 3001, Australia; 2. Centre for Nano Science and Engineering, Indian Institute of Science, Bangalore, India*

We show a theoretical analysis of second-order nonlinearity in unpoled SiN strip-loaded LNOI waveguides with bound states in the continuum predicting a conversion efficiency of 1000% W-1 cm-2.

AIP: Condensed Matter, Materials and Surface Physics / **371**

Radiation of Single Emitters Near Topological insulators

Authors: Andrew Greentree[1]; Benjamín Pavez[2]; Brant C Gibson[3]; EITAN DVORQUEZ[2]; Jerónimo Maze[2]; Qiang Sun[None]

[1] *RMIT University*

[2] *Institute of Physics, Pontificia Universidad Católica de Chile.*

[3] *ARC Centre of Excellence for Nanoscale Biophotonics, School of Science, RMIT University, Melbourne, Victoria 3000, Australia*

Our team from PUC Chile and RMIT studied how to amplify the small mixed reflection Fresnel coefficients for topological insulators via a third Mu-Metal sublayer and discovered a measurable Poynting vector deviation near its surface, key for its optical characterization.

Poster session / **372**

Aligning a wavelength selective switch with swept-wavelength digital holography

Authors: Mickael Mounaix[1]; Nicolas Fontaine[2]; David Neilson[None]; Joel Carpenter[1]

[1] *The University of Queensland*

[2] *Nokia Bell Labs*

We demonstrate the alignment of a wavelength selective switch by means of digital holography, allowing access to the spectrally-resolved full field of the output beams, a feature yielding additional insights such as crosstalk and spatial deformation of the beams.

Poster session / **373**

The characterization and electronic structure of nanostructured zirconium tellurides

Author: Darryl Jones[1]

Co-authors: Benjamin Chambers [1]; Christopher Gibson [1]; Tanglaw Roman [1]; Sarah Harmer [1]

[1] *College of Science and Engineering, Flinders University*

We explore the creation and characterization of exfoliated zirconium telluride nanostructures in order to investigate their electronic properties through a combination of photoemission electron microscopy and microARPES.

Precision and Quantum Sensing Workshop / **374**

Integrated optomechanical Magnetometer

Author: Fernando Gotardo[None]

We implemented nanofabrication to obtain an on-chip optomechanical magnetometer integrated with off-the-shelf laser and photodetector. Here we show the fabrication process and performance of our sensor.

7th International Workshop on Speciality Optical Fibres / **375**

Suppressing Stimulated Brillouin Scattering in Multimode Fibers with High Output Beam Quality

Author: Kabish Wisal[1]

Co-authors: Chun-Wei Chen [1]; Stephen Warrensmith [2]; Peyman Ahmadi [3]; Hui Cao [1]; A. Douglas Stone [1]

[1] *Yale University*

[2] *Future Industries Institute, University of South Australia*

[3] *Coherent*

We experimentally obtain a diffraction-limited focused spot at the output of a multimode fiber, resulting in increased SBS threshold(1.5x). We show theoretically and experimentally an even higher(2.3x) SBS threshold is obtained by axially offsetting the focused spot.

Joint session: AIP-BMP / COMMAD / 376

Semiconducting Polymer Nanoparticles: Enabling A New Frontier in Bioelectronic Neural Interfacing

Authors: Jessie Ann Posar[1]; Matthew James Griffith[None]; Natalie Holmes[1]; Nathan Brichta[2]; Paul Dastoor[3]; Rafael Crovador[3]; Rebecca Lim[3]

[1] *University of Sydney*

[2] *university of sydney*

[3] *University of Newcastle*

In this work, we report our group's recent efforts to create flexible and biocompatible neural interfaces. We combine soft carbon-based organic semiconductors and nanoscale science to print innovative bioelectrodes from functional nanoparticles that enable optical neurostimulation without requiring external power.

AIP: Condensed Matter, Materials and Surface Physics / 377

Observing varied magnetic phases in a van der Waals antiferromagnet using widefield nitrogen-vacancy centre microscopy

Author: Alex Healey[1]

[1] *University of Melbourne*

A magnetic study of the van der Waals antiferromagnet CuCrP2S6 showcasing the capabilities of widefield NV microscopy and uncovering a surprising range of magnetic phases in this material.

7th International Workshop on Speciality Optical Fibres / 378

Transverse Mode Instability Mitigation with Multimode excitation in Fiber Amplifiers

Author: Kabish Wisal[1]

Co-authors: Yaniv Eliezer [1]; A. Douglas Stone [1]; Hui Cao [1]; Chun-Wei Chen [1]

[1] *Yale University*

We show theoretically(and numerically) that TMI threshold increases linearly with number of equally excited modes in a multimode fiber amplifier. The multimode excitation is numerically focussed to a diffraction-limited spot, providing a stable high quality beam, with increased TMI threshold.

AIP: Theoretical and Mathematical / 379

Quantised mass-energy effects in a particle detector

Author: Carolyn Wood[1]

Co-author: Magdalena Zych [1]

[1] *The University of Queensland*

We show that mass–energy equivalence must be included in models of a quantum particle interacting with an external environment in order to represent physically relevant scenarios such as atom-light interactions.

7th International Workshop on Speciality Optical Fibres / 380

Sensing Figures of Merit for Terahertz Photonic Light Cages

Authors: Alessandro Tuniz[1]; Alessio Stefani[None]; Boris Kuhlmey[None]; Justin Digweed[None]; Mohammad Mirkhalaf[None]

[1] *The University of Sydney*

We discuss Figures of Merit for quantifying the sensing performance of hollow-core terahertz light cages with respect to free space propagation. Our results point to light cages as a way of improving terahertz phase sensing capabilities.

Poster session / 381

A Neutral Atom Quantum Processor Supporting Long Coherence Times

Author: Kristen Pudenz[None]

Atom Computing is creating a quantum processing platform based on nuclear spin qubits. The system makes use of optical tweezers to assemble and individually manipulate neutral strontium atoms. We demonstrate the robustness of these systems by characterizing their coherence times.

Australian and New Zealand Conference on Optics and Photonics / 382

Nonlinear frequency up-conversion in high-Q GaP metasurfaces

Author: Rocio Camacho[1]

Co-authors: Son Tung Ha ; Mohsen Rahmani ; Leonid Krivitskiy ; Lei Xu ; Haizhong Zhang ; Dragomir Neshev ; Arseniy I. Kuznetsov

[1] *The Australian National University*

Abstract - We demonstrate enhanced visible sum-frequency generation in doubly resonant GaP metasurfaces. Record conversion efficiency is achieved in the metasurface by the excitation of high-quality factor Q bound state in the continuum (BIC) resonances with non-trivial polarization dependence.

Australian and New Zealand Conference on Optics and Photonics / 383

Dielectric-plasmonic waveguide couplers: an explorer's map

Author: Alessandro Tuniz[1]

Co-authors: Giuseppe Della Valle ; Sabrina Garattoni

[1] *The University of Sydney*

We present a comprehensive and accessible "explorer's map" showing maximum coupling efficiencies and coupling lengths for dielectric-plasmonic directional couplers as a function of coupling strength and loss. This map is useful for designing any photonic integrated circuit containing plasmonic waveguides.

AIP: Atomic and Molecular Physics / 384

Breathing oscillations of a harmonically trapped one-dimensional quasicondensate: frequency beating and damping

Author: Karen Kheruntsyan[None]

Co-author: Francis Bayocboc, Jr.

We theoretically investigate breading oscillations of a harmonically trapped 1D quasicondensate at finite temperatures. We find that the oscillations exhibit beating of two oscillatory modes, unlike previous studies that predicted only a single oscillation frequency.

AIP: Atomic and Molecular Physics / 385

Emergent Universal Drag Law in a Model of Superflow

Author: Maarten Christenhusz[1]

Co-authors: Arghavan Safavi-Naini [2]; Halina Rubinsztein-Dunlop [3]; Matt Reeves [1]; Tyler Neely [3]

[1] *University of Queensland*

[2] *University of Amsterdam*

[3] *The University of Queensland*

We study the behaviour of drag in superfluids and observe the universal relation between the Reynolds number and drag coefficient in superflow. This establishes hydrodynamic scale invariance extends into the limit of quantum fluids.

Poster session / 386

Quench dynamics of the extended Su-Schrieffer-Heeger model

Author: Anirban Ghosh[1]

Co-authors: Andy Martin [2]; Sonjoy Majumder [1]

[1] *Indian Institute of Technology Kharagpur*

[2] *Unviversity of Melbourne*

In this work we study quench dynamics within the extended Su-Schrieffer-Heeger model. Specifically we consider the question if there is a quench between two topological states does the "path" of the quench impact the survival of the initial state.

AIP: Education / **387**

Ensuring the Quality of an Online Course with Changing Staff

Author: Thomas Dixon[1]

Co-authors: Elizabeth Angstmann [1]; Kate Jackson [1]

[1] *UNSW*

We run a large online-only physics course three times a year, with different academics and staff assigned each time. This talk outlines our work in ensuring consistency throughout the terms via course design and automation.

Poster session / **388**

Quench dynamics in the Jaynes-Cummings-Hubbard and Dicke models

Author: Andrew Hogan[1]

Co-author: Andy Martin [1]

[1] *University of Melbourne*

Both the Jaynes-Cummings-Hubbard and Dicke models can be thought of as idealised models of a quantum battery. In this work we examine the "charging" properties of such systems and find that there is no quantum advantage scaling with system size.

Poster session / **389**

Printable Micron-Resolution Organic Photocapacitors for Neural Interfacing

Authors: Jessie Ann Posar[1]; Matthew James Griffith[None]; Nathan Matthew Brichta[None]

[1] *University of Sydney*

In this abstract we detail a method of printing and testing a trichromatic organic photocapacitor for stimulating neurons via capacitive coupling. This work involves using a Sonoplot Microplotter II in conjuction with organic polymers dissolved in non-toxic solvents.

AIP: Atomic and Molecular Physics / 391

Vortex lattice nucleation in dipolar Bose-Einstein condensates

Author: Andy Martin[1]

Co-authors: Srivatsa Prasad [2]; Brendan Mulkerin [3]

[1] *University of Melbourne*

[2] *Newcastle University*

[3] *Monash University*

When subjected to a rotating magnetic field, the resulting precession of the dipole moments of a dipolar BEC imparts angular momentum to the system. We show how this can be used to generate vortex lattices, as observed in recent experiments.

Poster session / 392

Big time crystals in a bouncing BEC

Author: CHAMALI GUNAWARDANA[None]

Co-authors: Ali Zaheer ; Andrei Sidorov ; Arpana Singh ; Krzysztof Giergel ; Krzysztof Sacha ; Peter Hannaford ; Satoshi Tojo ; Tien Tran

We report on an experiment to create a big time crystal using a Bose-Einstein condensate of ultracold potassium - 39 atoms bouncing resonantly on a periodically driven atom mirror.

AIP: Atomic and Molecular Physics / 393

Dynamics of quasi-one-dimensional dipolar condensate droplets

Author: Junfan Wang[1]

Co-author: Andy Martin [1]

[1] *University of Melbourne*

We consider a quasi-one-dimensional dipolar BEC, with strong trapping along the two-axis orthogonal to the aligning dipole field (z-axis). When the z-axis trapping is switched off we numerically and analytically characterise the frequency and amplitude of the BEC width oscillations.

Precision and Quantum Sensing Workshop / 394

Towards perfect quantum sensing: gate-controlled bi-superconducting quantum interference devices.

Author: Thomas Kong[1]

Co-authors: Francesco Giazotto [2]; Giorgio De Simoni [2]; Giuseppe Tettamanzi [3]; Jace Cruddas [3]

[1] *The University of Adelaide*

[2] *Scuola Normale Superiore*

[3] *University of Adelaide*

It has been demonstrated that the behaviour of superconducting quantum interference devices can be precisely tuned using electrostatic gates. We discuss the recent experimental results and summarise our current theoretical understanding of this effect.

AIP: Quantum Science and Technology / 395

Passive superconducting circulator on a chip

Author: Arkady Fedorov[None]

We report the first realisation of a passive on-chip circulator which is made from a superconducting loop with three Josephson junctions and is tuned with only DC control fields. Our results demosntrated non-reciprocal behaviour and identified future path for improvement.

Poster session / 396

Respiratory Rate Monitoring Using Multimode Fibre Specklegram Sensor

Author: Md Nazmul Islam Sarkar[1]

Co-authors: Adam Kilpatrick [2]; David Lancaster ; Linh Viet Nguyen [1]; Stephen Warren-Smith

[1] *University of South Australia*

[2] *Adelaide Nursing School, The University of Adelaide*

We demonstrated of a multimode fibre specklegram sensor for noninvasive respiratory rate monitoring on a hospital mattress using deep learning.

AIP: Atomic and Molecular Physics / 397

Carrier-Envelope-Phase Effect for Multiphoton and Tunneling Excitation

Author: Rohan Glover[1]

Co-authors: Adam Palmer [2]; Andre Luiten [3]; Bruno deHarak [4]; Dashavir Chetty [2]; Han Xu [2]; Igor Litvinyuk ; Klaus Bartschat [5]; Nida Haram [2]; Phillip Light [1]; Robert Sang [2]; Xiao-Min Tong [6]

[1] *The University of Adelaide*

[2] *Griffith University*

[3] *University of Adelaide*

[4] *Illinois Wesleyan University*

[5] *Drake University*

[6] *University of Tsukuba*

We investigate excitation of atoms using extremely short pulses of light with intensities above 10^{14} W/cm^2. The carrier-envelope-phase of the pulse modifies the interaction and marks a change in the dynamics.

AIP: Relativity and Gravitation / **398**

Black holes, white holes, wormholes: their geometry and physics

Authors: Daniel Terno[None]; Murk Sebastian[1]; Robert Mann[2]

[1] *Macquarie University*

[2] *University of Waterloo*

Black holes, white holes and wormholes can be treated in a unified fashion. Starting from two natural assumptions many of their properties, sometimes in conflict with the usual semiclassical expectations, can be obtained.

Poster session / **399**

Listening to the seismic beats using distributed acoustic sensor over the campus telecommunication network

Author: Shahna Haneef[1]

Co-authors: Kasper Van Wijk [2]; Neil Broderick [3]

[1] *Research Fellow, University of Auckland*

[2] *Associate Professor, Department of Physics*

[3] *Professor, Department of Physics*

We report on the detection of seismic signals using Distributed Acoustic Sensor (DAS) over the dark fibers in the campus telecommunication network. The system implementation, data analysis and signal post-processing methods optimized in this study will be presented.

Poster session / **400**

Self-acceleration of non-Hermitian exciton-polariton wave packets

Author: Yow-Ming Hu[1]

Co-authors: Elena Ostrovskaya [1]; Eliezer Estrecho [2]

[1] *Australian National University*

[2] *The Australian National University*

We theoretically investigate the wavepacket dynamics in a non-Hermitian, optically anisotropic exciton-polariton system and observe their self-acceleration. We also describe the formation of pseudospin topological defects in momentum space.

AIP: Quantum Science and Technology / 401

Quantum control and foundational experiments

Authors: Caslav Brukner[1]; Daniel Terno[None]; Kai Wang[2]; Radu Ionicioiu[3]; Robert Mann[4]; Shining Zhu[2]; Xiaosong Ma[2]

[1] *University of Vienna*

[2] *Nanjing Univeristy*

[3] *National Institute of Physics and Nuclear Engineering*

[4] *University of Waterloo*

Hidden variable models that attempt to ascribe objective notion of being particle or wave contradict experiments. Quantum-controlled delayed choice experiments may show that they are internally inconsistent, and use of, entanglement makes them impossible to define.

AIP: Condensed Matter, Materials and Surface Physics / 403

Spatially resolved transport spectroscopy of few donor clusters in silicon

We present spatially-resolved spectroscopy of dopant-based atomic-scale devices in silicon using the resolution of low-temperature scanning tunnelling microscopy towards the fabrication and spectroscopy of artificial quantum matter in the context of dopant-based analogue quantum simulators in silicon

AIP: Education / 405

Making More Diffraction Orders by Shrinking Wavelengths

Author: Margaret Wegener[1]

Co-authors: Stephen Hughes [2]; Som Gurung [3]

[1] *School of Mathematics and Physics, The University of Queensland*

[2] *UQ College, The University of Queensland*

[3] *Paro College of Education, Royal University of Bhutan*

The change of wavelength of light with the medium it's travelling through can be demonstrated by immersing a simple diffraction experiment in water. Higher orders of diffraction can occur in water compared to in air.

Poster session / 406

Quantum optical levitation of a mirror

Author: Ryan Marshman[1]

Co-authors: Marco Ho [1]; Robert Mann ; Timothy Ralph

[1] *University of Queensland*

We present a quantum theory of a one dimensional optically levitated mirror. We consider the resulting entanglement between the mirror and cavity field and squeezing in the mirror output. We consider the visibility of this entanglement and thermal effects.

AIP: Theoretical and Mathematical / 407

Quantum asymmetry between space and time: Phenomenological emergence of Lorentz invariance

Author: Fatema Tanjia[1]

Co-authors: Aida Sadeghi [1]; Joan Vaccaro [1]

[1] *Griffith University*

Here we show that Lorentz invariance emerges phenomenologically in the new Quantum Theory of Time in a natural way, i.e. due to the Galilean transformation of the background T violating field.

Australian and New Zealand Conference on Optics and Photonics / 408

Towards pH Sensing in Hybrid Silk Materials for Wound Healing Applications

Author: Laura Hung[None]

Co-authors: Amanda Abraham [1]; Zlatko Kopecki [2]; Hanif Haidari [2]; Ethan Ellul [3]; Allison Cowin [2]; Robert McLaughlin [4]; Christina Bursill [5]; Asma Khalid [1]; Brant Gibson [1]

[1] *ARC Centre of Excellence for Nanoscale Biophotonics*

[2] *Future Industries Institute*

[3] *School of Science*

[4] *Faculty of Health and Medical Sciences*

[5] *South Australian Health and Medical Research Institute (SAHMRI)*

Research into a novel silk-hybrid material with capabilities of detecting pH changes in wound fluid via fluorescence spectroscopy may be implemented to assist in early detection of wound infection.

Poster session / 409

Entanglement based probe new macroscopic forces

Author: Ryan Marshman[1]

Co-authors: Anupam Mazumdar [2]; Peter Barker [3]; Sougato Bose [3]

[1] *University of Queensland*

[2] *Groningen University*

[3] *University College London*

We propose the use of charged, massive particle interferometers to probe for new or modifications to known forces at close range. We consider such a devices ability to detect Yukawa style modifications to gravity and the electromagnetic interactions.

AIP: Nuclear and Particle Physics / 410

The Nuclear EMC Effect

Author: Wanli Xing[1]

Co-author: Anthony Thomas [1]

[1] *University of Adelaide*

EMC Effect is the 40-year-old mystery that quark structure in free nucleons is somehow different to that in bound nucleons. We examine its two leading explanations - mean field correction and short-range correlation.

Conference on Optoelectronic and Microelectronic Materials and Devices / 411

V3O5: a promising material for solid-state neurons

Author: Sujan Kumar Das[1]

Co-authors: Armando Rúa [2]; Camilo Verbel Marquez [2]; David Albertini [3]; Etienne Puyoo [3]; Mutsunori Uenuma [4]; Nicolas Baboux [3]; Robert G Elliman [1]; Sanjoy Kumar Nandi [1]; Shimul Kanti Nath [1]; Teng Lu [5]; Thomas Ratcliff [1]; Yun Liu [5]

[1] *Research School of Physics, The Australian National University, Canberra, ACT, Australia*

[2] *Department of Physics, University of Puerto Rico, Mayaguez, Puerto Rico, USA*

[3] *Université Lyon, INSA Lyon, CNRS, Ecole Centrale de Lyon, CPE Lyon, INL, France*

[4] *Information Device Science Laboratory, Nara Institute of Science and Technology (NAIST), Nara, Japan*

[5] *Research School of Chemistry, The Australian National University, Canberra, ACT, Australia*

Vanadium oxide, metal-insulator transition, negative differential resistance, threshold switching, neuromorphic computing.

AIP: Theoretical and Mathematical / 412

Black Hole Thermodynamics in de Sitter Spacetimes

Author: Fil Simovic[1]

Co-author: Robert Mann [2]

[1] *Macquarie University*

[2] *University of Waterloo*

We study black hole thermodynamics in asymptotically de Sitter spacetimes, which is poorly understood owing to the presence of the cosmological horizon. We use a path integral approach to make equilibrium manifest, and study the resulting phase structure.

AIP: Quantum Science and Technology / 413

Tunable Gyromagnetic Augmentation of Nuclear Spins in Diamond

Author: Russell Goldblatt[None]

Co-authors: Alexander Wood [1]; Andy Martin

[1] *University of Melbourne*

We demonstrate rapid quantum control of optically-dark nuclear spins in diamond, which are typically isolated from both magnetic noise and oscillating control fields, through magnetic-field induced augmentation.

AIP: Biomedical and Medical Physics / 414

The effect of discrete wavelengths of visible light on the developing murine embryo

Author: Darren Jin Xiang Chow[None]

Co-authors: Carl Campugan [1]; Megan Lim [1]; Tiffany Tan [1]; Tong Li [1]; Avishkar Saini [1]; Anthony Orth [2]; Philip Reineck [3]; Erik Schartner [4]; Jeremy Thompson [1]; Kylie Dunning [1]; Kishan Dholakia [4]

[1] *The University of Adelaide*

[2] *National Research Council of Canada*

[3] *Royal Melbourne Institute of Technology*

[4] *Institute for Photonics and Advanced Sensing*

Light is present throughout the process of IVF. However, its impact on embryos remains unknown. Here we controlled for equivalent energy dose of light applied across wavelengths and found longer wavelengths of light to be detrimental to the embryo.

Poster session / 415

Rare B-meson decay processes in the ATLAS detector at CERN

Authors: Hitarthi Deepak Pandya[1]; Matthew Fewell[1]; Paul Jackson[2]

[1] *University of Adelaide (AU)*

[2] *University of Adelaide*

A brief survey of recent B-physics studies with the ATLAS detector at the LHC, concentrating on tests of the standard model of particle physics.

Poster session / **416**

A Moments Based Estimate of Trial State Fidelity for Variational Quantum Computation

Author: Floyd Creevey[None]

Co-authors: Charles Hill [1]; Harish Vallury ; Lloyd Hollenberg ; Michael Jones

[1] *The University of Melbourne*

We present a new parameter s_*, determined by Hamiltonian moments
⟨φ|H^n|φ⟩, as an estimate of the overlap between a trial state |φ⟩ and energy eigenstates of the problem Hamiltonian.

AIP: Quantum Science and Technology / **417**

Noise-robust energy estimates from deep circuits on real quantum computer hardware

Author: Harish Vallury[None]

Co-authors: Michael Jones ; Gregory White [1]; Floyd Creevey ; Charles Hill [1]; Lloyd Hollenberg

[1] *The University of Melbourne*

The Quantum Computed Moments (QCM) method offers a powerful correction to the ground state energy estimate obtained in variational quantum algorithms. We observe that this QCM estimate is incredibly robust to noise, and analyse the versatility of the approach.

AIP: Quantum Science and Technology / **418**

Ground-state energy estimation of molecular systems on physical quantum computers

Author: Michael Jones[None]

Co-authors: Charles Hill [1]; Harish Vallury ; Lloyd Hollenberg [1]

[1] *The University of Melbourne*

We discuss the challenges that must be overcome for variational quantum computing to be able to solve chemical systems of more than a few electrons in the context of the variational quantum eigensolver and the quantum computed moments method.

AIP: Atomic and Molecular Physics / **419**

Melting of vortex lattice in a two-dimensional BEC

Author: Tyler Neely[1]

Co-authors: Guillaume Gauthier [2]; Halina Rubinsztein-Dunlop [2]; Matthew Davis [2]; Matthew T. Reeves [1]

[1] *University of Queensland*

[2] *The University of Queensland*

In this work, we experimentally create a lattice of vortices in a two-dimensional BEC and map the vortex density as the lattice melts. These states have gained prominence as an analogue of electrons in the quantum hall effect.

Australian and New Zealand Conference on Optics and Photonics / 420

Modelling of noise in Brillouin-based storage and retrieval

Author: Christopher Poulton[1]

Co-authors: Matthew Arnold [1]; Michael Steel [2]; Mikolaj Schmidt [2]; Oscar Nieves

[1] *University of Technology Sydney*

[2] *Macquarie University*

We present a numerical and analytical investigation of thermal noise processes in Brillouin experiments. We focus on Brillouin-based memory experiments, and explore the effects of noise on information retrieval for amplitude and phase-based storage with different pulse configurations.

AIP: Computational and Mathematical Physics / 423

Exotic superfluids in multi-component homogeneous Bose-Einstein condensates

Author: Matthew Edmonds[1]

Co-author: Matthew Davis [1]

[1] *University of Queensland*

We explore the properties of uniform quasi-two-dimensional condensates with several interacting internal degrees of freedom, which we model in terms of a multi-component Gross-Pitaevskii equations in the rotating frame for a Bose-Einstein condensate in different experimentally realistic box geometries.

Australian and New Zealand Conference on Optics and Photonics / 424

A wireless camera based optical elastography probe towards intraoperative breast cancer detection

Author: QI FANG[1]

Co-authors: Aiden Taba [1]; Benjamin Dessauvagie [1]; Brendan Kennedy [1]; Christobel Saunders [2]; Imogen Boman [1]; Kyle Newman [1]; Renate Zilkens [1]; Rowan Sanderson [1]; Seokhyun Choi [1]

[1] *The University of Western Australia*

[2] *The University of Melbourne*

We present a compact, wireless imaging probe using a cost-effective camera-based technique, stereoscopic optical palpation, towards intraoperative tumour assessment for breast cancer surgery. This probe could help surgeons effectively remove cancer during the operation, reducing the need for follow-up surgery.

Australian and New Zealand Conference on Optics and Photonics / 425

Confining sound in superfluids via optomechanics

Co-authors: Andreas Sawadsky Sawadsky ; Christopher Baker [1]; Glen Harris [1]; Walter Wasserman [1]; Warwick Bowen [1]

[1] *The University of Queensland*

The coupling of light with a mechanical degree of freedom is ususally limited to exciting mechanical modes that are defined by the structure being used. We are working towards a regime where light can be used to define mechanical modes.

AIP: Nuclear and Particle Physics / 426

Searching for Dark Matter with The ORGAN Experiment: Results, Status, and Future Plans

Authors: Ben McAllister[None]; Aaron Quiskamp[None]; Michael Tobar[None]

We present the current status and future plans of the experiments within The Oscillating Resonant Group AxioN (ORGAN) Collaboration, which develops axion haloscopes. Axions are a compelling dark matter candidate, and haloscopes are a tool for axion searches.

Poster session / 427

Synthetic superfluid chemistry with vortex-trapped quantum impurities

Author: Matthew Edmonds[1]

Co-authors: Minoru Eto [2]; Muneto Nitta [3]

[1] *University of Queensland*

[2] *Yamagata University*

[3] *Keio University*

We study how impurity atoms can be trapped within superfluid vortices in a two-component BEC. This leads to distorted vortex profiles and a mass-dependent splitting of the impurities energy. The excited states of the impurity show effects analogous to chemistry.

Poster session / 428

High-precision study of E1 transition amplitudes for single-valence atoms and ions

Authors: Benjamin Roberts[None]; Carter Fairhall[1]; Jacinda Ginges[None]

[1] *The University of Queensland*

We perform a detailed study of electric dipole transitions in K, Ca^+, Rb, Sr^+, Cs, Ba^+, Fr, and Ra^+, which are of interest for studies of atomic parity violation, electric dipole moments, polarizabilities, and the development of atomic clocks.

AIP: Quantum Science and Technology / 429

Designing a Quantum Matterwave Vortex Gyroscope

Authors: John Close[1]; Ryan Husband[2]; Ryan Thomas[1]; Samuel Legge[1]; Simon Haine[1]

[1] *Supervisor*

[2] *PhD Student*

Quantum sensors exhibit promising real-world applications of quantum mechanics that exploit its most counterintuitive properties. I present an ongoing project that aims to design, build, and test a new type of quantum rotation sensor, the vortex matterwave gyroscope.

AIP: Nuclear and Particle Physics / 430

The SABRE South Experiment

Author: Irene Bolognino[1]

[1] *The University of Adelaide, Adelaide, SA 5005, Australia. ARC Centre of Excellence for Dark Matter Particle Physics, Australia.*

The SABRE-South experiment, located at SUPL, Australia, aims to detect dark matter to provide a model independent test of the signal observed by DAMA/LIBRA.
This talk will describe the complexity of SABRE-South and the general status of its assembly.

AIP: Group for Astroparticle Physics / Astronomy / 431

Gamma-ray and Neutrino Emission from Supernova Remnants and Molecular Clouds

Author: Ryan Burley[1]

Co-authors: Gary Hill [1]; Gavin Rowell [1]; Sabrina Einecke [1]

[1] *University of Adelaide*

In this contribution, we present our study on predicting observable fluxes of gamma rays and neutrinos created in the hadronic collisions of particles accelerated by Galactic supernova remnants with nearby molecular gas clouds.

Australian and New Zealand Conference on Optics and Photonics / **432**

Robust Optical Fibre Sensors for Harsh Wastewater Environments

Author: Martin Ams[1]

[1] *Macquarie University*

We report robust fibre Bragg grating (FBG) sensors that optically measure environmental conditions in harsh, corrosive, biofouling wastewater networks over long periods.

AIP: Condensed Matter, Materials and Surface Physics / **433**

Bogoliubov excitations of a polariton condensate in dynamical equilibrium with an incoherent reservoir.

Author: Olivier Bleu[1]

[1] *Monash University*

In this joint theory-experiment work, we study Bogoliubov excitations of a polariton condensate in dynamical equilibrium with an incoherent excitonic reservoir.

Poster session / **434**

Overlap Removal at the ATLAS Experiment

Author: Edmund Xiang Lin Ting[1]

[1] *University of Adelaide (AU)*

Overlap removal is an integral step in all ATLAS analyses wherein ambiguities in object reconstruction are resolved. Established methods compare the geometric distance between reconstructed objects. These will be compared to new approaches based on Global Particle Flow.

AIP: Quantum Science and Technology / **435**

Imaging stars with quantum error correction

Author: Zixin Huang[1]

Co-author: Gavin Brennen [1]

[1] *Macquarie University*

We present a general framework for using quantum error correction codes for protecting and imaging starlight received at distant telescope sites, which can enable long-baseline optical interferometry.

AIP: Group for Astroparticle Physics / Astronomy / 436

Search for a Variation of the Fine Structure Constant around the Supermassive Black Hole in Our Galactic Centre

Author: Benjamin Roberts[None]

We search for a variation of the fine-structure constant using measurements of late-type evolved giant stars from the S star cluster orbiting the supermassive black hole in our Galactic Centre.

Australian and New Zealand Conference on Optics and Photonics / 437

Resonant Spectroscopy of Blue Quantum Emitters in Hexagonal Boron Nitride

Author: Jake Horder[1]

[1] *University of Technology Sydney*

Characterisation of spectral properties of blue SPEs in hBN at cryogenic temperatures. High-yield fabrication allows for extensive study of this defect class. Resonant excitation revealed phonon-broadened linewidth as well as Rabi oscillations.

AIP: Condensed Matter, Materials and Surface Physics / 438

Quantum to classical behavior of exciton-polarons

Author: Brendan Mulkerin[None]

Co-authors: Antonio Tiene [1]; Francesca Marchetti [2]; Jesper Levinsen [3]; Meera Parish

[1] *Universidad Autónoma de Madrid*

[2] *Universidad Autonoma de Madrid*

[3] *Monash University*

We present our theoretical investigations on finite temperature exciton-polaritons in doped transition-metal dichalcogenides monolayers. We apply a virial expansion to the many-body Green's function, which allows for the exact calculation of the absorption spectrum and photoluminesence.

Poster session / 439

Quantum measurement and control with massive mechanical oscillators

Author: Matt Woolley[1]

[1] *UNSW Canberra*

Measurement and control of massive mechanical oscillators in the quantum regime is now possible [Nature 556, 478 (2018); Science 372, 625 (2021)]. I will describe this work and the possibilities it enables for sensing with non-classical mechanical systems moving forwards.

AIP: Quantum Science and Technology / 440

Updated Quantum Master Equations for Simulation of Open Quantum Dynamics

Author: Teerawat Chalermpusitarak[None]

Co-author: Gerardo Paz Silva [1]

[1] *Griffith*

We introduce a new method to simulate the dynamics of an open quantum system by using a hierarchy of master equations, which update not only the relevant information about the system but also the leading correlations of the bath operators.

Poster session / 441

Coupling Spin Defects in Hexagonal Boron Nitride to Monolithic Bullseye Cavities

Author: Lesley Spencer[1]

[1] *UTS / TMOS*

In this work we integrate a spin centre in hexagonal boron nitride with a monolithic photonic resonator in an intial step towards a scalable spin-photon interface.

Australian and New Zealand Conference on Optics and Photonics / 442

Multimodal fibre-optic imaging probe for detection of atherosclerotic plaques using fluorescent nanoparticles

Author: Rouyan Chen[1]

Co-authors: Lauren Sandeman [2]; Victoria Nankivell [2]; Joanne Tan [2]; Gang Zheng [3]; Peter Psaltis [2]; Christina Bursill [2]; Robert McLaughlin [4]; Jiawen Li [1]

[1] *School of Electrical and Electronic Engineering, The University of Adelaide, Adelaide, SA 5005, Australia.*

[2] *South Australian Health and Medical Research Institute (SAHMRI), Adelaide, SA, 5000 Australia*

[3] *Department of Medical Biophysics, University of Toronto, Ontario M5G1L7, Canada*

[4] *Faculty of Health and Medical Sciences, The University of Adelaide, Adelaide, SA 5005, Australia*

This project utilises a miniaturised fibre-optic probe with dual-modality imaging capability that can simultaneously acquire optical coherence tomography and fluorescence in diseased blood vessels of mice injected with fluorescent nanoparticles.

AIP: Condensed Matter, Materials and Surface Physics / 443

Photoemission Electron Microscopy and Momentum Microscopy of 2D Transition Metal Chalcogenides

Author: Sarah Harmer[1]

Co-authors: Benjamin Chambers [2]; Darryl Jones [2]; Tanglaw Roman [2]

[1] *Flinders University*

[2] *College of Science and Engineering, Flinders University*

Photoemission is the most information rich and widely used techniques for the elucidation of the electronic structure, surface states and chemistry of materials. The NanoESCA III, recently commissioned in Flinders Microscopy and Microanalysis.

Australian and New Zealand Conference on Optics and Photonics / 444

Development of upconversion glass for true-3D tabletop display

Authors: Erik Schartner[1]; George Melnik[2]; Heike Ebendorff-Heidepriem[None]; Matthew Kappers[2]; Nelson Tansu[None]; Ramez Elgammal[2]; Thomas de Prinse[3]; Xuanzhao Pan[4]; Yunle Wei[3]

[1] *Institute for Photonics and Advanced Sensing (IPAS) & School of Physical Sciences, The University of Adelaide, Adelaide 5005, SA, Australia*

[2] *The Coretec Group Inc.*

[3] *The University of Adelaide*

[4] *School of Physical Sciences, The University of Adelaide, Adelaide, SA, 5005, Australia*

We fabricated and examined a range of low phonon energy glasses doped with Er3+ that have the potential to be used as scalable imaging chamber material for upconversion based 3D display.

AIP: Biomedical and Medical Physics / 445

A Systematic Review of the Proton and Carbon FLASH Effect

Author: Jake Atkinson[1]

[1] *University of South Australia*

FLASH is an emerging radiotherapy modality that enhances normal tissue sparing whilst maintaining tumour kill efficacy. This talk will summarise recent preclinical proton- and carbon-FLASH literature, and the predicted radiobiological mechanisms responsible for the 'FLASH effect' phenomenon.

AIP: Nuclear and Particle Physics / 447

Characterizing and Modelling Weakly Collective Nuclei - Puzzles and Progress

Author: Andrew Stuchbery[1]

[1] *The Australian National University*

Advances and open questions on the structure of weakly collective nuclei will be discussed, beginning with a shell model perspective, and emphasizing the insights and puzzles that result from recently measured electromagnetic observables.

Australian and New Zealand Conference on Optics and Photonics / 448

Resonant harmonic generation from nonlinear dielectric metasurfaces

Author: Kirill Koshelev[1]

Co-author: Yuri Kivshar [1]

[1] *Australian National University*

We predict and demonstrate experimentally strong third-harmonic optical signal for broken-symmetry dielectric metasurfaces supporting sharp optical resonances in the near-IR. For chiral asymmetric dielectric metasurfaces we demonstrate experimentally large nonlinear chiroptical response in transmission.

Poster session / 449

Using quantum theory to predict dark matter fractions of galactic halos

Author: Allan Ernest[1]

[1] *Charles Sturt University*

Quantum theory applied to gravitational potentials, in conjunction with a galaxy's halo temperature, can be used to understand why some galaxies are dark matter dominated while others are observed to have almost no dark matter.

Poster session / 451

Critical Velocity and Vortex Nucleation for Superfluid Flow Past a Finite Obstacle

Author: Charlotte Quirk[None]

We characterise the emergence of vortex pairs in stationary solutions of superfluid flow past a finite obstacle, both analytically and numerically. We demonstrate how this leads to the breakdown of superfluidity at the critical velocity.

Poster session / 452

Utilising Second-Order Correlation Algorithms for Improved Single Photon Source Measurements

Author: Mitchell de Vries[1]

Co-authors: Brant Gibson ; Brett Johnson ; Davin Yue Ming Peng [2]; Philipp Reineck

[1] *RMIT University*

[2] *Australian Research Council Centre of Excellence for Nanoscale Biophotonics, RMIT University*

We present a quantitative comparison of algorithms commonly supplied with time tagging hardware, as well as more sophisticated algorithms presented in the literature. It is apparent that different signal-to-noise ratios and measurement efficiencies can be achieved through these different algorithms.

AIP: Education / 453

What Aurora Reveals About the Physics Study and STEM Career Choices Among Schoolgirls

Author: Maria Parappilly[1]

[1] *Flinders University*

I seek to discuss the insights from 6 years of the Aurora Contest data to understand the reach and knowledge of this contest and outreach activities that can shape STEM study, in particular Physics and related career choices among schoolgirls.

AIP: Solar Terrestrial and Space Physics / 454

Absolute Laser Frequency Readout of Cavity for Next Generation Geodesy Mission

Author: Emily Rees[None]

Co-authors: A.R. Wade [1]; A.J. Sutton [1]; K. McKenzie [1]

[1] *Australian National University*

We demonstrate the absolute frequency calibration of a laser using a free spectral range cavity readout designed for next generation geodesy missions.

AIP: Quantum Science and Technology / 455

Quantum self-oscillation with time-delay feedback

Author: Yanan Liu[1]

Co-authors: Jason Twamley [2]; William Munro [3]

[1] *Griffith University*

[2] *Quantum Machines Unit, OIST*

[3] *NTT Basic Research Laboratories & NTT Research Center for Theoretical Quantum Physics*

We designed a quantum optical version of time delayed self-sustained oscillations, which has focused towards developing quantum clocks.

Australian and New Zealand Conference on Optics and Photonics / 456

Calibration Methods for in vivo Microrheology with Rotational Optical Tweezers

Author: Mark Watson[1]

Co-authors: Alexander Stilgoe ; Timo Nieminen ; Itia Favre-Bulle ; Jennifer Stow ; Halina Rubinsztein-Dunlop [1]

[1] *The University of Queensland*

Rotational Optical Tweezers provides a unique tool to perform dynamic microrheology of intracellular vesicles using an internalised vaterite microsphere. Here, we discuss the required calibration of trapping power and the probe radius for successful microviscometry.

AIP: Quantum Science and Technology / 458

Artificial Neural Network Decoding for the Surface Code

Author: Spiro Gicev[1]

Co-authors: Lloyd Hollenberg [2]; Muhammad Usman [2]

[1] *University of Melbourne*

[2] *The University of Melbourne*

We have developed an artificial neural network decoding technique for large scale surface codes with complex boundaries suffering a variety of noise models.

Poster session / 459

Laser Stabilisation Techniques for Space Applications

Author: Namisha Chabbra[1]

Co-authors: Alberto Stochino ; Andrew J. Sutton ; Andrew Wade [2]; Daniel Shaddock ; Emily Rees ; Kirk McKenzie ; Robert Ward

[1] *Australian National University*

[2] *The Australian National University*

We present ‘tilt locking’ as a potential candidate for laser stabilisation for space applications and demonstrate the performance at stabilization limits near the standard RF approaches.

Poster session / **460**

Over 200 mW single-frequency Tm-doped fiber ring laser at 2.05 μm

Author: Lu Zhang[1]

Co-authors: Quan Sheng [2]; Junxiang Zhang [3]; Shijie Fu [3]; Wei Shi [3]; Jianquan Yao [4]

[1] *TIANJIN UNIVERSITY*

[2] *Tianjin university*

[3] *Tianjin University*

[4] *Tianjin univeristy*

A 215 mW single-frequency thulium-doped ring-cavity fiber laser operating at 2050 nm based on Tm/Ho-codoped fiber saturable absorber has been proposed and experimentally demonstrated for the first time.

AIP: Atomic and Molecular Physics / **461**

A New Concept in Positron Polarimetry

Author: Joshua Machacek[1]

Co-authors: Sean Hodgman [1]; Stephen Buckman [1]; Timothy Gay [2]

[1] *Australian National University*

[2] *University of Nebraska-Lincoln*

We will present a novel method to determine the polarization state of a positron beam via interaction with a spin-polarized target to produce positronium atoms and discuss the theoretical limit on its analysing power.

Australian and New Zealand Conference on Optics and Photonics / **463**

First Observation of Fluorescence above 1200 nm from a Silicon-Related Colour Centre in Diamond

Author: Mitchell de Vries[1]

Co-authors: Adam Dalis [2]; Alastair Stacey [1]; Brant Gibson ; Brett Johnson ; Nathalie de Leon [3]; Philipp Reineck ; Sounak Mukherjee [3]; Timothy Dumm [2]; Zihuai Zhang [3]

[1] *RMIT University*

[2] *Hyperion Materials & Technologies*

[3] *Princeton University*

We present the first observation and characterisation of a photoluminescence colour centre in diamond with a zero phonon line at 1220nm accompanied by prominent phonon side band replicas. The temperature dependence, excitation power and wavelength, and PL lifetime are presented.

Precision and Quantum Sensing Workshop / 464

Towards a compact Ytterbium magneto optical trap for use in precision timekeeping applications

Author: Benjamin White[1]

Co-authors: Andre Luiten [1]; Ashby Hilton [1]; Ben Sparkes [2]; Charlie Ironside [3]; Rachel Offer [1]; William Rickard [3]; Xiao Sun [3]

[1] *University of Adelaide*

[2] *Defence Science and Technology Group*

[3] *Curtin University*

We report on progress towards a compact Ytterbium cold atom trap system, including the fabrication of grating magneto-optical trap chips and compact ovens. The aim is to develop a high-performance field deployable optical clock.

Poster session / 465

Positron Transport in the Positronium Formation Regime

Author: Joshua Machacek[None]

Co-authors: Dale Muccignat [1]; Greg Boyle [1]; Robert McEachran [2]

[1] *James Cook University*

[2] *Australian National University*

We will discuss our investigation into the inclusion of the positronium formation cross section, both empirically and theoretically determined, in the calculation of transport properties in the noble gases.

Poster session / 466

Scalable Nanomechanical Computing

Author: Timothy Hirsch[1]

Co-authors: Christopher Baker ; Erick Romero ; Glen Harris ; Nicolas Mauranyapin ; Rachpon Kalra ; Warwick Bowen

[1] *University of Queensland*

Nanomechanical computers promise radiation robust, low energy information processing, however no scalable approach has so far been devised. Here we experimentally demonstrate a scalable, CMOS-compatible nanomechanical logic gate that could realistically scale to an energy cost close to Laundauer's bound.

Conference on Optoelectronic and Microelectronic Materials and Devices / 467

Superconducting Aluminium-Silicon Ring Devices

Author: Manjith Bose[1]

Co-authors: Michael Stuiber [2]; Daniel Creedon [1]; Amanuel Berhane4 ; Laurens Willems van Beveren ; Sergey Rubanov [3]; Jared Cole [4]; Vincent Mourik [5]; Alex Hamilton [6]; Tim Duty ; Jeff McCallum [7]; Brett Johnson

[1] *The University of Melbourne*

[2] *Melbourne Centre for Nanofabrication (MCN)*

[3] *University of Melbourrne*

[4] *RMIT University*

[5] *UNSW, Sydney*

[6] *UNSW*

[7] *University of Melbourne*

A fabrication process for unique AlSi alloy nanowires and corresponding magneto-resistance data presented.

Australian and New Zealand Conference on Optics and Photonics / 468

The Hanbury Brown and Twiss experiment as a tool for emitter localization

Author: Jaret Vasquez-Lozano[1]

Co-authors: Andrew Greentree [1]; Shuo Li [1]

[1] *RMIT*

By simulating the Hanbury Brown and Twiss experiment results (second order correlation function) for a field of emitters, we study the effectiveness of using quantum correlations in emitter localisation.

AIP: Nuclear and Particle Physics / 470

Study of ttH production at the HL-LHC

Author: Isabel Beth Carr[1]

Co-author: Geoffrey Norman Taylor [1]

[1] *University of Melbourne (AU)*

We present an investigation into the ttH process, including the capability for measuring the Higgs boson ‘invisible’ decays with the HL-LHC and ATLAS detector upgrade.

Australian and New Zealand Conference on Optics and Photonics / 471

Lasing and amplification in titanium doped sapphire whispering gallery mode resonator

Author: Luke Trainor[1]

Co-authors: Dmitry Strekalov ; Maya Isarov ; Ang Gao ; Farhan Azeem [2]; Harald Schwefel

[1] *University of Otago*

[2] *Department of Physics, University of Otago, Dunedin, New Zealand.*

We present a high quality titanium doped sapphire whispering gallery mode (WGM) resonator with record low lasing threshold and high slope efficiency. We also show that amplification is readily achievable.

Poster session / **472**

Linewidth Measurement and Frequency Control of High Power, Single Frequency, Diamond Raman Laser (DRL)

Author: Richard Pahlavani[1]

Co-authors: Douglas Little [1]; Ondrej Kitzler [2]; Rich Mildren [1]

[1] *Macquarie University*

[2] *MQ Photonics Research Centre, School of Mathematical and Physical Sciences, Faculty of Science and Engineering, Macquarie University*

Recent developments in several fields require high power narrow linewidth lasers. Here, we measure the linewidth of a high power, single frequency DRL. We furthermore propose as a novel static frequency control mechanism, with speeds comparable to piezo-electric devices.

AIP: Computational and Mathematical Physics / **474**

Electron Energy Deposition in Molecular Hydrogen: A Monte Carlo Simulation Using Accurate Cross Sections

Authors: Dmitry Fursa[1]; Igor Bray[1]; Liam Scarlett[1]; Mark Zammit[2]; Reese Horton[None]

[1] *Curtin University*

[2] *LANL*

A simulation of the process of electron energy deposition in molecular hydrogen in the energy range 0–500 eV is reviewed. Ionisation and dissociative effects are examined and a new numerical method for sampling continuum excitations is presented.

AIP: Group for Astroparticle Physics / Astronomy / **475**

A Compound Poisson Generator approach to Point-Source Inference in Astrophysics

Author: Gabriel Collin[None]

I will present a new statistical approach to the problem of inferring the properties of point-source populations. This method will be shown to be superior to existing methods in the context of X-ray astronomy.

AIP: Education / **476**

Preparing First Year Physics students for Laboratory assessment

Author: Jacinta den Besten[1]

Co-author: James Klein [1]

[1] *The University of Melbourne*

Using a combination of rubrics, sample work and a quiz module with clear goals and expectations to prepare students for participating and writing in physics teaching laboratories. Student improvements and outcomes are presented.

AIP: Quantum Science and Technology / **477**

Wigner and his Friend's Recursive Experiment

Author: Anibal Utreras-Alarcon[1]

Co-authors: Eric Cavalcanti [1]; Howard Wiseman [1]

[1] *Griffith University*

Studying the correlations within a bipartite sequential Wigner's friend experiment, in particular when compared to the already known correlations of a scenario with the same number of inputs and outputs under a local hidden variable model.

Poster session / **479**

Experimental Investigation of Ring Cavity Architecture on Holmium Fibre Laser Mode-locked Stability

Author: Alexandros Kolovinos[None]

Co-authors: David McAfee [1]; Keiron Boyd [1]; Miftar Ganija [1]

[1] *DST Group Edinburgh*

Mode-locked soliton pulses are shaped by intensity-dependent nonlinear effects. Consequently, fibre laser design provides insight into the evolution of these ultrashort pulses. We present mode-locking performance for a variety of component selections and positions in a Holmium fibre ring cavity.

AIP: Quantum Science and Technology / **480**

From many-body to many-time physics

Author: Gregory White[1]

Co-authors: Felix Pollock [2]; Lloyd Hollenberg [1]; Charles Hill [1]; Kavan Modi [2]

[1] *The University of Melbourne*

[2] *Monash University*

We develop and demonstrate a set of tools for both detailed and efficient characterisation of the full set of temporal correlations present in quantum dynamics. Applications range from noise reduction to the general study of open quantum systems.

Poster session / **481**

The ATLAS silicon strip tracker upgrade

Author: James Webb[1]

Co-author: Geoffrey Taylor [2]

[1] *University of Melbourne (AU)*

[2] *University of Melbourne*

An overview of the ATLAS strip tracker upgrade programme, with a focus on the testing and optimisation of assembly procedures in the lead up to end-cap module construction at the University of Melbourne.

Poster session / **482**

MEMS based silicon-air-silicon long wave infrared spectrometer

Author: Hemendra Kala[1]

Co-authors: Adrian Keating [1]; Dhirendra Kumar Tripathi ; Dilusha Silva [1]; Gino Putrino ; Lorenzo Faraone [1]; Mariusz Martyniuk [1]; Michal Zawierta [1]

[1] *The University of Western Australia*

Micro Electro-Mechanical Systems (MEMS) based Fabry Perot interferometers offer low size, weight, and power (SWaP) platforms for carrying out spectroscopic and chemical/biological sensing while being mechanically robust and field-portable unlike traditional bulk-optics based techniques.

Australian and New Zealand Conference on Optics and Photonics / **483**

Multi-Spatial Mode Readout Of Optical Cavities For Reduced Brownian Coating Thermal Noise

Authors: Andrew Wade[1]; Namisha Chabbra[2]

Co-author: Kirk McKenzie [1]

[1] *The Australian National University*

[2] *Australian National University*

This talk will outline a new approach to mitigating Brownian coating thermal noise in optical cavities using multiple higher-order gaussian modes. We will present results of a theoretical study into this new sensing scheme and plans for an experimental implementation.

Poster session / **485**

Multi-scale modelling of STM devices with in-plane degenerately doped contacts

Author: Mushita Masud Munia[1]

Co-authors: Abu Mohammad Saffat-Ee Huq ; Michelle Simmons [2]; Rajib Rahman [2]; Yu-Ling Hsueh [2]

[1] *University of New South Wales*

[2] *The University of New South Wales*

We demonstrate a hybrid quantum-semiclassical multi-scale modeling approach to characterize degenerately phosphorus-doped in-plane contacts and their impact on the energy states of the precision placed donor quantum dots under different bias conditions in silicon STM devices.

7th International Workshop on Speciality Optical Fibres / **486**

Multipoint fibre Bragg grating sensors for industrial temperature monitoring

Author: Erik Schartner[None]

Co-authors: Dale Otten [1]; David Lancaster ; Heike Ebendorff-Heidepriem ; Linh Viet Nguyen [1]; Stephen Warren-Smith

[1] *University of South Australia*

We report on the use of multipoint Bragg gratings fabricated in suspended core optical fibres in industrial temperature sensing applications.

AIP: Nuclear and Particle Physics / **487**

Internal structure of the nucleon through global QCD analysis

Author: Wally Melnitchouk[1]

[1] *Jefferson Lab*

We report on recent advances in reconstructing the internal quark and gluon structure of the nucleon through global QCD analysis of high energy scattering data.

Poster session / **489**

Exploring the quantum interference of neutral matter waves reflected from ultra-thin films and surfaces

Author: David Cortie[None]

See attached word document

Joint session: AIP-BMP / COMMAD / **490**

Semiconducting Polymer X-ray Detectors with Non-Fullerene Acceptors for Enhanced Stability: Towards Printable, Flexible, and Tissue Equivalent Devices

Author: Jessie Ann Posar[1]

Co-authors: Nathan Brichta [1]; Marco Petasecca [2]; Matthew Griffith [1]

[1] *University of Sydney*

[2] *University of Wollongong*

A novel tissue-equivalent organic x-ray detector was fabricated from polymer donor P3HT and non-fullerene acceptor o-IDTBR exhibiting superior optoelectronic properties for high operating efficiencies under x-rays without bias. Insights into radiation-induced damage mechanisms enabled material modifications to improve device stability.

AIP: Quantum Science and Technology / **491**

Conditional quantum states of a continuously monitored mechanical oscillator

Author: Soroush Khademi[1]

Co-authors: Howard Wiseman [2]; James Bennett [2]; Kiarn Laverick [2]; Warwick Bowen [1]

[1] *The University of Queensland*

[2] *Griffith University*

We present novel quantum frameworks for inferring the quantum state of the mechanical oscillator in different scenarios and elaborate on how they are applied to a resonator in the lab.

Precision and Quantum Sensing Workshop / **492**

Effects of Wavefront Curvature in Optical Atomic Beam Clocks

Author: Aidan Strathearn[None]

Co-authors: Ashby Hilton [1]; Elizaveta Klantsataya [1]; Rachel Offer [1]; Tom Stace [2]

[1] *University of Adelaide*

[2] *University of Queensland*

We develop an analytic model for atomic beam clocks, incorporating a realistic laser profile with wavefront curvature. Our model explains previous empirical observations about signal optimisation and enables further optimisation of stability and accuracy.

Australian and New Zealand Conference on Optics and Photonics / 493

Inducing guided long-wavelength acoustic waves in a non-suspended waveguide

Author: Choon Kong Lai[None]

Co-authors: Alvaro Casas Bedoya [1]; Benjamin Eggleton [1]; Christopher Poulton [2]; Michael Steel [3]; Moritz merklein [1]; Stephen Madden [4]; Yang Liu [5]

[1] *Institute of Photonics and Optical Science (IPOS), school of Physics, The University of Sydney*

[2] *School of Mathematical and Physical Sciences, University of Technology Sydney (UTS)*

[3] *MQ Photonics Research Centre, School of Mathematical and Physical Sciences, Macquarie University*

[4] *Research school of Physics, Australian National University*

[5] *Institute of Physics, Swiss Federal Institute of Technology Lausanne (EPFL), Switzerland*

Inducing forward Brillouin scattering (FBS) in non-suspended waveguides is challenging because the required acoustic waves have long wavelengths, typically exceeding the acoustic mode cutoff. Here, we investigate the extent to which an acoustic mode can be confined in non-suspended platforms.

7th International Workshop on Speciality Optical Fibres / 494

A 10 W narrow-linewidth thulium fibre master oscillator power amplifier

Author: Georgia Bolingbroke[1]

[1] *University of Adelaide*

We describe the development of ultra-stable single-frequency 10W thulium fibre master oscillator power amplifiers at wavelengths between 1900nm and 2050nm, for gravitational wave detection. Environmental isolation and minimal wavelength drift is achieved using a two-stage temperature-controlled mount.

Poster session / 495

Ray Tracing for Refractive Index Matching Free Optical Projection Tomography

Author: Zixin Liang[1]

Co-authors: Adrian Sheppard [2]; Glenn Myers [2]; Roland Fleddermann [3]

[1] *Centre for Gravitational Astrophysics, The Australian National University*

[2] *Department of Materials Physics, The Australian National University*

[3] *Centre for Gravitational Astrophysics and Department of Materials Physics, The Australian National UniversityUniversity*

Reconstruction techniques with the aid of ray tracing are investigated for a custom-built OPT system operated without applying index matching material to strongly refracting objects.

AIP: Nuclear and Particle Physics / 496

Pulse Shape Discrimination of low-energy nuclear and electron recoils in NaI:Tl for dark matter direct-detection

Author: Nathan Spinks[None]

WIMPs are a strongly motivated dark matter candidate, expected to produce measurable nuclear recoils, while background events produce electron recoils. Classification of recoil events is important for improved detection of dark matter. PSD approaches are developed to improve event classification.

Australian and New Zealand Conference on Optics and Photonics / 497

All in a spin: rotational levitated optomechanics

Author: Kishan Dholakia[None]

Optical levitation of micro and nanoparticles in vacuum offer new approaches for precision measurement and fundamental physics. We will discuss the use of rotational degree of freedom for achieving high Q values, rotational-translational dynamics and sympathetic cooling of microparticles.

Poster session / 499

A Simple, High sensitivity, Wideband Wavefront Sensor

Author: Thomas Roocke[None]

We report the development of a high sensitivity, quadrant-photodiode-based Hartmann wavefront sensor. The sensor is simple, low cost, with a bandwidth of 50kHz, and a sensitivity and dynamic range for curvature change of 10/um and 0.5/m, respectively.

AIP: Quantum Science and Technology / 500

Modulating the quantum noise of interacting exciton-polaritons in the spontaneous emission regime with a spectral filter

Author: Thomas Volz[1]

Co-author: Lorenzo Scarpelli [1]

[1] *Macquarie University*

In this talk we will show how a spectral filter, together with a weak Kerr nonlinearity, can be used to tune, and improve, the photon statistics of the spontaneous emission of a strongly-confined exciton-polariton system.

Poster session / **502**

Progress on the fast photoionisation detection of a single Er3+ ion in Si

Author: Chunming Yin[1]

[1] *University of Science and Technology of China*

This presentation provides recent progress on fast photoionisation detection of a single Er3+ ion using radio-frequency reflectometry and spectral broadening of single ions with the aim of developing efficient deterministic readout of single optical centres.

AIP: Relativity and Gravitation / **503**

The Optical Limit of Phase Measurement in Space Based Interferometry

Author: Callum Sambridge[None]

Co-authors: Andrew J. Sutton ; Andrew Wade [1]; Jobin Thomas Valliyakalayil [2]; Kirk McKenzie ; Lyle Roberts

[1] *The Australian National University*

[2] *Centre for Gravitational Astrophysics, Australian National University*

This talk discusses a rigorous analysis of phasemeter behaviour in the ultra weak-light regime. We explore the fundamental limit in optical power at which heterodyne phase tracking measurements can be reliably performed, Focused on application in space-based interferometry.

Australian and New Zealand Conference on Optics and Photonics / **504**

Lunar Communications with the ANU Optical Ground Station

Author: Michael Copeland[1]

Co-authors: Francis Bennet [1]; Marcus Birch [1]; Kate Ferguson [1]; Doris Grosse [1]; Noelia Martinez Rey [1]; Tony Travouillon [1]

[1] *Australian National University*

We report on development of a transmitter and receiver for lunar optical communications. The instruments will be installed on the ANU Optical Communications Ground Station (OCGS) at Mt Stromlo Observatory in Canberra, Australia.

Poster session / **506**

Bound states in microwave QED: Crossover from waveguide to cavity regime

Author: Pradeep Nandakumar[1]

Co-authors: Andr\'es Rosario Hamann [2]; Arkady Fedorov [2]; Maximilian Zanner [3]; Mikhail Pletyukhov [4]; Rohit Navarathna [1]

[1] *ARC Center for Engineered Quantum Systems and Department of Maths and Physics, University of Queensland*

[2] *ARC Center for Engineered Quantum Systems and Department of Physics ETH Zurich*

[3] *IQOQI, University of Innsbruck, Austria*

[4] *RWTH Aachen University, Germany*

In this work we present a unifying theory based on Green's function that realistically model waveguides talking into accounting finite size and boundaries. We then apply our formalism to experimentally study Atom-Photon Bound states in a rectangular waveguide QED system.

Australian and New Zealand Conference on Optics and Photonics / **507**

How to Engineer Optomechanical Coupling Using NV Defects

Author: Mikolaj Schmidt[1]

Co-authors: Christopher Poulton [2]; Daniel Burgarth [1]; Gavin Brennen [1]; Michael Steel [1]

[1] *Macquarie University*

[2] *University of Technology Sydney*

Coupling optical and mechanical modes of microresonators is usually engineered by harnessing their intrinsic nonlinear material response. We propose to harness a new coupling mechanism, in which relies an ensemble of nitrogen vacancies (NVs) induces the effective nonlinearity in diamon.

Poster session / **508**

Tensor E-graphs for Lattice QCD Nuclear Correlation Function Calculations

Author: Nabil Humphrey[None]

Co-authors: James Zanotti [1]; Ross Young ; William Detmold

[1] *The University of Adelaide*

The newly developed tensor e-graph optimisation technique provides an efficient approach to compute correlation functions of multi-hadron states in lattice QCD. Benchmarks of numerical performance are presented for tensor e-graph optimisation applied to correlation functions for interpolating operators of nuclei.

Australian and New Zealand Conference on Optics and Photonics / 509

Optically detected spin transitions in an Er-doped whispering-gallery resonator

Author: Luke Trainor[1]

Co-authors: Gavin King [1]; Harald Schwefel [1]; Jevon Longdell [1]; Li Ma [1]

[1] *University of Otago*

We present an erbium-doped optical resonator with a quality factor of 10^8 and up to 1.2GHz of coupling to an optical transition. By probing the optical resonances we can measure the erbium's response to microwave excitation of its spin transition.

AIP: Quantum Science and Technology / 510

Experimental Analysis of State Injection for Error-Corrected Quantum Systems

Author: Anthony O'Rourke[1]

Co-authors: GOZDE USTUN [2]; Jason Gavriel [3]

[1] *The University of Technology Sydney*

[2] *UNSW*

[3] *University of Technology Sydney*

How to experimentally investigate the fidelity of injected states for error-corrected quantum computing using the surface code and superconducting qubits. The injection method with the highest resultant fidelity minimises the need for resource-intensive state distillation.

AIP: Nuclear and Particle Physics / 511

Low-lying Odd-parity Nucleon Resonances in Hamiltonian Effective Field Theory

Author: Curtis Abell[None]

Co-authors: Anthony Thomas [1]; Derek Leinweber [2]; Jiajun Wu [3]

[1] *University of Adelaide*

[2] *CSSM, University of Adelaide*

[3] *University of Chinese Academy of Sciences*

By performing a combined analysis of data from pion-Nucleon scattering experiments with first-principles calculations from lattice QCD, we gain insight into the composition and structure of the low-lying odd-parity Nucleon resonances.

Australian and New Zealand Conference on Optics and Photonics / 512

Periodic Poling of Thin-Film Lithium Niobate for Quasi-Phase Matching

Author: Aditya Dubey[1]

Co-authors: Andreas Boes [2]; Armandas Balčytis [1]; Arnan Mitchell [1]; Guanghui Ren [1]; Max Herbold [1]; Mengxi Tan [1]; Sumeet Walia [1]; Thach Nguyen [1]

[1] *RMIT University*

[2] *RMIT University, University of Adelaide*

In this contribution, we investigate periodic poling of 300nm thin-film X-cut lithium niobate on insulator and study the correlation between applied voltage pulses and domain evolution for efficient second-order nonlinear optical frequency conversion processes.

Australian and New Zealand Conference on Optics and Photonics / 513

Statistics of Light Emitted from Ultra-Strongly Coupled Quantum Systems

Author: Mikolaj Schmidt[1]

Co-authors: Alvaro Nodar [2]; Javier Aizpurua [2]; Michael Steel [1]; Ruben Esteban [2]; Unai Muniain [2]

[1] *Macquarie University*

[2] *University of the Basque Country, Spain*

In this work, we show that light emitted from generic Ultra-Strongly Coupled system demonstrates suprising, unbounded strong bunching of photons. We explain the origin of this effect, its dependence on driving mechanism, and discuss potential applications.

AIP: Condensed Matter, Materials and Surface Physics / 514

Engineering the Two-Dimensional Hole Gas on Diamond by Surface Transfer Doping for Future Carbon Electronics

Author: Dongchen Qi[None]

See the attachment.

AIP: Quantum Science and Technology / 515

Algorithms for quantum non-Markovianity

Author: Christina Giarmatzi[1]

Co-author: Alexei Gilchrist [2]

[1] *University of Technology Sydney*

[2] *Macquarie University*

We provide a suite of methods to discover the causal model of a quantum process. It is the first complete toolkit for quantum causal discovery, taking into account experimental and computational limitations.

Conference on Optoelectronic and Microelectronic Materials and Devices / 516

Integration of black phosphorus photoconductors with lithium niobate on insulator photonics

Author: Shifan Wang[1]

Co-authors: Alberto Peruzzo [2]; Brett Johnson [2]; Inna Krasnokutska [2]; James Bullock [1]; Kibret Messalea [2]; Robert Chapman [3]; Jean-Luc Tambasco [2]

[1] *The University of Melbourne*

[2] *RMIT*

[3] *ETH Zurich*

For the first time, we integrate two-dimensional black phosphorus photoconductors onto waveguides fabricated on the emerging lithium niobate-on-insulator platform, and demonstrate efficient on-chip detection at telecommunication wavelengths.

Poster session / 517

Building a Real-Time Quantum Random Number Generator

Author: Mikhael Sayat[1]

Co-authors: Aaron Tranter [2]; Angela Baiju [2]; John Cater [1]; Nicholas Rattenbury [1]; Oliver Thearle [3]; Ping Koy Lam [4]; Sebastian Kish ; Syed M. Assad [4]

[1] *University of Auckland*

[2] *Australian National University*

[3] *Defence Science & Technology Group*

[4] *ANU*

A continuous variable real-time quantum random number generator which extracts random numbers from the shot noise clearance of a vacuum state homodyne measurement will be built. It will include periodic real-time system health checks, tests, and alerts.

AIP: Relativity and Gravitation / 518

Enhanced laser noise suppression for LISA using arm and cavity locking

Authors: Jobin Valliyakalayil[1]; Andrew Sutton[1]; Robert Spero[2]; Daniel Shaddock[1]; Kirk McKenzie[1]

[1] *Centre for Gravitational Astrophysics, Australian National University*

[2] *Jet Propulsion Laboratory, California Institute of Technology*

This research illustrates a novel method of stabilizing the laser in the LISA mission with respect to two references – the on-board optical cavity, and the inter-spacecraft separations or the arms of the interferometer

Australian and New Zealand Conference on Optics and Photonics / 519

Spectrally tunable metasurface filters for long-wavelength infrared range

Author: Fedor Kovalev[1]

Co-authors: Ilya Shadrivov [2]; Lorenzo Faraone [3]; Mariusz Martyniuk [3]; Michal Zawierta [3]; Mingkai Liu [1]; Oleg Bannik [3]

[1] *The Australian National University*

[2] *Australian National University*

[3] *The University of Western Australia*

To realise a tunable filter in the long wavelength infrared range, we integrate a metasurface with a micro-electro-mechanical system. Proposed devices will make an impact in remote infrared imaging and sensing.

Poster session / 520

Tuning Luminescence Resonance Energy Transfer for Lifetime-Based Multiplexing Detection of Nucleic Acids

Authors: Jianguo Jia[1]; Yiqing Lu[1]

[1] *Macquarie University*

Multiplexing detection of nucleic acids has been developed using the temporal dimension of luminescence lifetimes, which are tuned by Luminescence Resonance Energy Transfer between a donor europium complex and an acceptor dye tagged onto oligonucleotides, decoded by time-resolved image cytometry.

Conference on Optoelectronic and Microelectronic Materials and Devices / 521

Superconducting microwave resonators for spin-photon coupling in silicon

Author: upender singh[None]

Co-authors: Benoit Voisin [1]; Gabriele De Boo [2]; Ian Berkman [2]; Sven Rogge [2]

[1] *Center for Quantum Computation and Communication Technology, UNSW School of Physics, Sydney NSW 2052, Australia;Silicon Quantum Computing, Sydney NSW 2052, Australia*

[2] *Center for Quantum Computation and Communication Technology, UNSW School of Physics, Sydney NSW 2052, Australia*

We characterize superconducting Tungsten Silicide films for high kinetic inductance. The films are then used to fabricate superconducting microwave resonators with high internal quality factors, and resilience to in-plane magnetic fields with potential applications in scale-up quantum computing.

Poster session / **522**

Limitations on feasibility of satellites for distributed quantum computer networks

Authors: Hudson Leone[None]; Srikara Shankara[None]

Co-author: Simon Devitt

In the context of Distributed Quantum Computing,this work demonstrates the impediments on the usage of satellites for distributing entanglement between two error-corrected quantum computers on earth separated by varying distances.

AIP: Quantum Science and Technology / **523**

Satellite-to-Ground Discrete Modulated Continuous Variable Quantum Key Distribution

Author: Mikhael Sayat[1]

Co-authors: Biveen Shajilal [2]; John Cater [1]; Nicholas Rattenbury [1]; Ping Koy Lam [3]; Sebastian Kish ; Syed M. Assad [3]

[1] *University of Auckland*

[2] *Australian National University*

[3] *ANU*

Discrete modulated continuous variable quantum key distribution (CVQKD) performs better than Gaussian modulated CVQKD in low signal-to-noise-ratio (SNR) regimes. We present results on the study of its performance in a satellite-to-ground context in the asymptotic and finite-size limit.

AIP: Education / **524**

Bunjee Jumping: Using modelling and technology to improve student engagement with uncertainty analysis

Author: Srividya Durga Kota[None]

Co-authors: Jacinta den-Besten [1]; Manjula Sharma [2]

[1] *The University of Melbourne*

[2] *The University of Sydney*

In this presentation we will provide results of a study conducted in first-year physics laboratories involving an experiment, Bunjee Jumping. The experiment is designed with a conceptual framework integrating technology and modelling to specifically 'engage' students with uncertainty analysis.

Poster session / **526**

Fiber-coupled multiplexed independent Ho:ZBLAN waveguide chip lasers in a single substrate

Author: Dale Otten[1]

Co-authors: Lachlan Harris [1]; Yongsop Hwang [1]; Dmitrii Stepanov [2]; David Lancaster

[1] *University of South Australia*

[2] *Defence Science and Technology Group*

An easily re-configurable, compact and scalable 2 μm holmium in ZBLAN laser source with multi-channel/wavelength fiber outputs of >100mW is presented and discussed.

AIP: Group for Astroparticle Physics / Astronomy / **527**

Constraining the Number of Neutrino Sources from Events Observed by IceCube using Importance Sampling

Author: Ella Roberts[None]

Co-authors: Bruce Dawson [1]; Gary Hill [1]

[1] *University of Adelaide*

In this contribution, we show how we constrain the number of neutrino sources that produce the high-energy astrophysical neutrino events observed by IceCube using importance sampling to maximise a multidimensional marginal likelihood.

Poster session / **528**

Characterization of the cosmogenic background in NaI(Tl)

Author: Yi Yi Zhong[1]

[1] *ANU*

A NaI(Tl) crystal was irradiated by a strong cosmic ray-like neutron beam to characterize the cosmogenic background in NaI(Tl).This study will inform the development and analysis of NaI(Tl)-based experiments and also improve their sensitivity to probe dark matter.

Australian and New Zealand Conference on Optics and Photonics / **529**

Real-Time Imaging of Nanoparticle Transcytosis in a Microfluidic Blood–Brain Barrier Model

Author: Yueying Cao[None]

Co-authors: Bingyang Shi [1]; Guoying Wang [1]; James A. Piper [1]; Jia Li [1]; Jun Zhang [1]; Xianlin Zheng [1]; Yiqing Lu [1]

[1] *Macquarie University*

We have developed a nanoparticle tracking method for direct observation of the in-vitro BBB penetration process, enabling in-depth studies of the mechanisms and pathways for nanoparticle agents to penetrate the blood-brain barrier.

AIP: Condensed Matter, Materials and Surface Physics / 531

Rydberg Exciton-Polaritons in a Magnetic Field

Author: Emma Laird[1]

Co-authors: Francesca Marchetti [2]; Dmitry Efimkin [3]; Meera Parish [3]; Jesper Levinsen [3]

[1] *University of Queensland*

[2] *Autonomous University of Madrid*

[3] *Monash University*

We have the first exact solution of exciton-polaritons in magnetic fields, which agrees extremely well with experiments.

Conference on Optoelectronic and Microelectronic Materials and Devices / 532

Insight into the nature of blue emitters in hexagonal Boron Nitride via Stark effect

Author: Ivan Zhigulin[None]

Stable single photon quantum emitters in hexagonal Boron Nitride (hBN) can be deterministically created in the material and consistently emit at 436 nm wavelength. This work conducted Stark effect measurements on a number of blue emitters to investigate their nature.

Poster session / 533

Structured light in optical tweezers for functional microstructures.

Authors: Declan Armstrong[1]; Alexander Stilgoe[1]; Timo Nieminen[1]; Halina Rubinsztein-Dunlop[1]

[1] *The University of Queensland*

We investigate methods and applications of in-situ aberration correction, utilising a modified holographic optical trapping setup, to rapidly fabricate high-resolution 3D microstructures for studying biological systems

Conference on Optoelectronic and Microelectronic Materials and Devices / 534

Optimising CVD boron doped diamond with a novel 3D-printed titanium Faraday cage for an all diamond superconducting device platform

Author: Yi Jiang[1]

Co-authors: Alastair Stacey [2]; Daniel Creedon [1]; David Jamieson [3]; Jeff McCallum [3]; Kumaravelu Ganesan [1]; Steven Prawer [4]

[1] *The University of Melbourne*

[2] *RMIT University*

[3] *University of Melbourne*

[4] *The University of Melbourne School of Physics*

Here we report the optimization of the growth of superconducting boron doped diamond on insulating diamond substrates via microwave plasma chemical vapor deposition (MPCVD) using a 3D-printed titanium Faraday cage, which leads to superior uniformity in growth and boron incorporation.

Australian and New Zealand Conference on Optics and Photonics / 535

Silicon photonics with T centre spin-photon devices

Author: Daniel Higginbottom[None]

Co-authors: Adam DeAbreu [1]; Camille Bowness [1]; Joshua Kanaganyagam [1]; Leea Stott [1]; Mehdi Keshavarz [1]; Michael Thewalt [1]; Myles Ruether [1]; Nicholas Brunelle [1]; Sarah Hosseini [1]; Stephanie Simmons [1]

[1] *Simon Fraser University*

Spin-photon devices for on-chip silicon photonic quantum networks are demonstrated using the silicon T centre, a spin photon interface boasting long-lived spin qubits and spin-resolving optical transitions in a telecommunications band.

Australian and New Zealand Conference on Optics and Photonics / 536

Reverse-wave suppression in ring-resonator lasers

Author: David Ottaway[1]

Co-authors: Elizaveta Klantsataya [1]; Gabriel Britto Monteiro ; Peter Veitch [1]; Sarah Watzdorf [2]

[1] *University of Adelaide*

[2] *IPAS*

Ring resonators are used to produce injection-seeded, transform-limited pulsed lasers for remote sensing applications. Injection-seeding generally forces uni-directional operation. Our pulsed laser showed both directions were equally seeded. We developed a model that shows <0.1% forward-to-reverse-wave coupling can cause this.

AIP: Relativity and Gravitation / 537

Characterization of laser offset phase locking for a Newtonian noise sensor

Author: Sheon Chua[1]

Co-authors: Avanish Kulur Ramamohan [1]; Bram Slagmolen [2]; Ya Zhang [1]

[1] *Australian National University*

[2] *The Australian National University*

We present the characterization of the simultaneous four offset-optical phase-locked loop set up used as part of a Newtonian noise sensor readout, and discuss their performance and limits with respect to the scientific requirements for the experiment.

Australian and New Zealand Conference on Optics and Photonics / 538

Mid infrared optical waveguide couplers

Author: TONEY teddy fernandez[1]

Co-authors: Alex Fuerbach [1]; Benjamin Johnston [1]; Michael Withford [1]; Simon Gross [1]

[1] *Macquarie University*

The femtosecond laser direct write technique was used to fabricate mid-infrared waveguide couplers into fused silica and compositionally engineered fluoride glass for the first time. Both results are compared and contrasted to demonstrate novel application regimes.

Poster session / 539

Optical detection of VOCs using metal-organic framework decorated metasurfaces

Authors: Alisba John[1]; Antonio Tricoli[2]; Buddini Karawdeniya[1]; Dragomir Neshev[1]; Krishnan Murugappan[1]; Shridhar Manjunath[3]

[1] *Australian National University*

[2] *University of Sydney and Australian National University*

[3] *ARC Centre of excellence TMOS*

We employ high quality-factor nano resonators coated with metal-organic frameworks to obtain high sensitivity and selectivity towards a specific VOC. In this work, we have demonstrated a LOD of 400 ppm in ambient conditions which aids to test hyperglycaemic condition.

AIP: Nuclear and Particle Physics / 540

Fixed Field Accelerators for Particle Therapy

Author: Adam Steinberg[1]

Co-authors: Robert Appleby [2]; Suzie Sheehy [3]

[1] *University of Melbourne / University of Manchester / Cockcroft Institute*

[2] *University of Manchester*

[3] *University of Melbourne / ANSTO*

Fixed Field Accelerators offer potential advantages for particle therapy, however many challenges remain. We address the problem of resonance crossing during acceleration, showing that beam stability can be maintained by fixing the normalised focusing strength.

AIP: Quantum Science and Technology / 541

Extending the low-frequency limit of qubit noise spectroscopy beyond the inverse dephasing time

Author: Xi Yu[1]

Co-authors: Andrea Morello [1]; Benjamin Wilhelm [1]; Gerardo Paz-Silva [2]; Yuanlong Wang [3]

[1] *University of New South Wales*

[2] *Griffith University*

[3] *Key Laboratory and Systems and Control, Academy of Mathematics and System Science, Chineses Academy of Sciences, Beijing, China*

We propose and demonstrate a novel spectroscopy method on donor spin qubit in silicon, which resolves the challenge of low frequency noise estimation with fine resolution

AIP: Nuclear and Particle Physics / 542

Weak charge of the proton

Author: Ross Young[None]

We report on a recent determination of the weak charge of the proton in parity-violating electron–proton scattering. The result is in excellent agreement with the standard model prediction, providing bounds on new physics interactions at the multi-TeV mass scale.

Poster session / 543

Optical homogeneous broadening and site identification of Er in Si

Authors: Alexey Lyasota[1]; Bin-Bin Xu[1]; Brett Johnson[2]; Chunming Yin[1]; Gabriele de Boo[1]; Ian Berkman[1]; Jeffrey McCallum[2]; John Bartholomew[3]; Matthew Sellars[4]; Rose Ahlefeldt[4]; Shouyi Xie[1]; Sven Rogge[1]

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[2] *Centre of Excellence for Quantum Computation and Communication Technology, School of Physics, University of Melbourne, Victoria 3010, Australia*

[3] *Centre for Engineered Quantum Systems, School of Physics, The University of Sydney, Sydney, New South Wales 2006, Australia*

[4] *Centre of Excellence for Quantum Computation and Communication Technology, Research School of Physics, Australian National University, Canberra, Australian Capital Territory 0200, Australia*

Using resonant photoluminescence spectroscopy, we show a 350 kHz upper bound on homogeneous broadening, less than 400 MHz inhomogeneous linewidth and long spin lifetimes of Er in Si. These parameters are promising for future quantum information and communication applications.

AIP: Quantum Science and Technology / 544

Quantum Chaos and Entanglement

Authors: Kavan Modi[1]; Neil Dowling[None]

[1] *Monash University*

We realise a common principle that applies to a wide range of seemingly distinct concepts and diagnostics of quantum chaos. We use this to identify a fundamental link between quantum chaos and entanglement.

AIP: Quantum Science and Technology / 545

Reducing Overhead for Quantum Advantage in Topological Data Analysis

Author: Dominic Berry[1]

Co-authors: Abhishek Rajput [2]; Casper Gyurik [3]; Joao Basso [4]; Nathan Wiebe [2]; Ryan Babbush [4]; Vedran Djunko [3]; Yuan Su [4]

[1] *Macquarie University*

[2] *University of Toronto*

[3] *Leiden University*

[4] *Google Quantum AI*

Topological data analysis is an important way of understanding features of data, but can be exponentially hard classically. We present new ways of performing topological data analysis on a quantum computer with improved complexity.

Poster session / 546

Progress Towards a Fixed Field Beamline in Melbourne

Author: Adam Steinberg[1]

Co-authors: Hannah Norman [1]; Jacinta Yap [2]; Robert Appleby [3]; Suzie Sheehy [4]

[1] *University of Melbourne / University of Manchester / Cockcroft Institute*

[2] *University of Melbourne*

[3] *University of Manchester*

[4] *University of Melbourne / ANSTO*

A design study is ongoing for a fixed field beamline to transport proton beams from 0.5-3.5MeV. Magnet prototyping and particle simulations are underway to demonstrate technologies enabling rapid depth scanning for hadron therapy.

AIP: Quantum Science and Technology / 547

Causal Mediation in Quantum Causal Models

Authors: Jason Pearl[1]; Markus Frembs[1]; Eric Cavalcanti[1]

[1] *Griffith University*

We analyse the ontological models framework underlying Spekkens' formalism for contextuality, in the light of quantum causal models. We argue that QCMs can maintain the spirit of noncontextuality by rejecting classical assumptions about how intermediate causes screen off correlations.

AIP: Computational and Mathematical Physics / 548

Enhanced screening in polymer melts with periodic boundary conditions

Author: Nathan Clisby[1]

Co-author: Burkhard Dünweg [2]

[1] *Swinburne University of Technology*

[2] *Max Planck Institute for Polymer Research*

We study polymer melts via high precision Monte Carlo simulations of Hamiltonian paths of up to N = 100 million steps on the simple cubic lattice with periodic boundary conditions.

7th International Workshop on Speciality Optical Fibres / 549

How to Build a High Performance MPLC: From Simulation to Fabrication

Authors: Daniel Dahl[1]; Joel Carpenter[1]; Nicolas Fontaine[2]

[1] *The University of Queensland*

[2] *Nokia Bell Labs*

We describe a repeatable method for building and characterising a multi-plane light convertor that operates as a 55 spatial mode sorter.

Poster session / 550

An Investigation of MEMS-based Photonic Switch Structure

Author: Yan Liu[None]

A novel energy-efficient and high-performance MEMS-based mechanical switching structure with a suspended waveguide is investigated for developing the applications of high-speed optical communication networks, hyper-scale datacenter and data-intensive computing systems.

Australian and New Zealand Conference on Optics and Photonics / 551

Probing Photon Correlation in Spontaneous Emission of Lanthanide Nanocrystals

Author: Peng Ren[None]

Co-authors: Cyril Laplane ; Yueying Cao ; James A Piper ; Thomas Volz ; Yiqing Lu [1]

[1] *Macquarie University*

We explore the lifetime and cross-correlation of different sizes NaYbxY1-xF4 (x = 20%, 50% and 100%) nanoparticles. The lifetime reduces when Yb doping concentration increases, The g2(0) of NaYbYF4 is over 10, but only for nanocrystal size below 40 nm.

Poster session / 552

High-dimensional Stokes-space Spatial Beam Analyser

Authors: Daniel Dahl[1]; Joel Carpenter[1]; Martin Ploschner[2]; Mickael Mounaix[1]; Nicolas Fontaine[3]

[1] *The University of Queensland*

[2] *School of ITEE, The University of Queensland*

[3] *Nokia Bell Labs*

We demonstrate a device for measuring the generalized Stokes parameters of a six spatial mode beam. The device is a single-shot wavefront sensor measuring spatial complex amplitude and coherence without an external phase reference.

AIP: Atomic and Molecular Physics / 553

Decay of sound waves in ring-shaped Bose-Einstein condensates

Author: Andrew Groszek[1]

[1] *The University of Queensland*

To study the viability of a rotation sensing scheme using ultracold atoms, we numerically model the decay of standing waves excited in the density of a ring-shaped Bose-Einstein condensate.

Australian and New Zealand Conference on Optics and Photonics / 554

2D materials for quantum integrated photonics

Author: Sejeong Kim[1]

[1] *University of Melbourne*

Quantum technologies require the interfacing of numerous single photons on a chip. Integration between quantum light sources and photonic devices is crucial for this purpose. Here, we present the integration of hBN quantum emitters into photonic waveguides and photonic cavities.

AIP: Relativity and Gravitation / **556**

Tolerance of Hartmann Wavefront Sensors to third-order optical aberrations in the projecting telescopes

Author: Madison Simmonds[None]

Co-authors: Daniel Brown [1]; David Ottaway [1]

[1] *University of Adelaide*

Designing Hartmann wavefront sensor telescopes for improved sensing of thermal aberrations in large diameter optics inside gravitational wave interferometers.

Poster session / **557**

Measuring Rotation in a Bose Einstein Condensate with Phonon Interferometry

Author: Charles Woffinden[1]

[1] *University of Queensland*

We demonstrate the use of a ring-shaped Bose-Einstein condensate as a rotation sensor by measuring the interference between two counter-propagating phonon modes.

AIP: Quantum Science and Technology / **558**

Quantum algorithm for time-dependent differential equations using Dyson series

Author: Dominic Berry[1]

Co-author: Pedro Costa [1]

[1] *Macquarie University*

We provide a quantum algorithm for time-dependent differential equations with only logarithmic dependence on the error and derivative. It can be applied to discretised partial differential equations for simulation of classical physics.

Poster session / **559**

Origin of the baryon magnetic polarisability

Author: Thomas Kabelitz[None]

Co-authors: Derek Leinweber [1]; Waseem Kamleh [2]

[1] *CSSM, University of Adelaide*

[2] *University of Adelaide*

New insight into the quark mass dependence of octet baryon magnetic polarisabilities is created by confronting lattice QCD with a constituent quark model description of fractionally charged baryons where individual quark sector contributions are isolated.

Australian and New Zealand Conference on Optics and Photonics / **560**

Measuring Magnetic Fields at Arbitrary Frequencies with an Atomic Magnetometer

Authors: Andre Luiten[1]; Chris Perrella[2]; Kyle Netz[2]; Rujie Li[2]

[1] *The University of Adelaide, QuantX Labs*

[2] *University of Adelaide*

Calculating the Larmor precession phase evolution to measure magnetic fields at arbitrary frequencies with an Non-linear Magneto-Optical Rotation (NMOR) atomic magnetometer.

Poster session / **561**

Dynamics of Nanotube Electromechanical Oscillator Coupled to Single Electron Transistor

Author: Govind Sasikumar[1]

Co-authors: Andrey Miroshnichenko [1]; Matt Woolley [1]

[1] *School of Engineering and Information Technology, UNSW Canberra, ACT, 2600, Australia.*

We model the dynamics of nanomechanical oscillator coupled to single electron transistor using the nonlinear Fokker-Planck equation in the regime where transport is fast compared to mechanical dynamics. The calculations are compared with recent experimental results.

Conference on Optoelectronic and Microelectronic Materials and Devices / **562**

The Electrical Nature of Au-hyperdoped Si

Author: Shao Qi Lim[1]

Co-authors: Brett Johnson [2]; Christian Notthoff [3]; Jeffrey Warrender [4]; Jim Williams [3]

[1] *Centre of Quantum Computation and Communication Technology, School of Physics, University of Melbourne*

[2] *RMIT*

[3] *Research School of Physics, The Australian National University*

[4] *US Army Combat Capabilities Development Command – Armaments Center, Watervliet, NY, USA*

Au-hyperdoped Si has recently shown promise as a Si-based near-infrared detector. Here, we show electrical characterization measurements of Au-hyperdoped Si in an effort to optimize device architecture and detector efficiency.

Poster session / **563**

Simulations and design of a compact beamline for Inverse Compton Scattering at the University of Melbourne X-lab

Authors: Geoffrey Norman Taylor[1]; Matteo Volpi[1]; Roger Rassool[2]; Rohan Dowd[3]; Scott David Williams[1]; Suzie Sheehy[4]

[1] *University of Melbourne (AU)*

[2] *The University of Melbourne*

[3] *Australian Synchrotron - ANSTO*

[4] *University of Oxford and University of Melbourne*

A presentation of the conceptual design and simulation of a compact beamline using high gradient X-band accelerating structures at the University of Melbourne X-lab which can be used as input for an Inverse Compton Scattering X-ray light source.

AIP: Quantum Science and Technology / **564**

An Evolutionary Algorithm for the Circuit Synthesis of Arbitrary Quantum States

Author: Floyd Creevey[None]

Co-authors: Charles Hill [1]; Lloyd Hollenberg

[1] *The University of Melbourne*

We present a method – genetic algorithm for state preparation (GASP) – which generates low-depth quantum circuits for initialising a quantum computer in a specified quantum state.

Poster session / **565**

Triplet-Triplet Annihilation: Magnetic Field Effects in Solution

Author: Roslyn Forecast[1]

Co-authors: Francesco Campaioli [1]; Jared Cole

[1] *RMIT University*

Triplet-triplet annihilation is a spin-selective process which exhibits a magnetic field response. Here we revisit the fundamental theory used to model this field response, explaining the origins of key equations and the assumptions behind them.

AIP: Quantum Science and Technology / 567

Identification and mitigation of quantum relaxometry temporal artifacts

Author: Ella Walsh[None]

Co-authors: Anthony Chesman [1]; David Simpson [2]; Di Wang [3]; Erin Grant [4]; Liam Hall [5]; Sepehr Ahmadi [1]

[1] *CSIRO Manufacturing*

[2] *The University of Melbourne School of Physics*

[3] *School of Chemsitry, The University of Melbourne*

[4] *The University of Melbourne*

[5] *School of Chemistry, the University of Melbourne*

In the practical implementation of relaxometry techniques, systematic errors arise in the quantum state preparation that need to be mitigated for the accurate monitoring of external stimuli. This talk presents strategies to address such limitations for practical applications.

Focus Session / 568

Lattice-induced optical chirality in all-dielectric resonant metasurfaces

Author: Piyush Jangid[1]

Co-authors: Sergey Kruk [1]; Yuri Kivshar [1]

[1] *Australian National University*

We present a novel direction to enhance and control the degree of chirality in silicon-on-silica metasurfaces via an interplay between the nanoresonator symmetry and the symmetry of the metasurface lattice.

Poster session / 569

Frequency control of diamond Raman lasers for guide star applications

Author: Rich Mildren[1]

Co-authors: Adam Bennet [1]; Adam Sharp [1]; David Spence [1]; Hadiya Jasbeer [1]; Mojtaba Moshkani [1]; Ritayan Roy [1]; Xuezong Yang [2]

[1] *Macquarie University, Australia*

[2] *UCAS, China*

Reporting on the development of next-generation guide star laser technology using diamond Raman laser that aims to increase power, provides frequency stabilization, and narrow laser linewidth required for guide star applications.

Poster session / **570**

Molecular convergent close-coupling calculations for the ionisation of H2 and its isotopologues

Author: Eric Jong[1]

Co-authors: Bary Schneider [2]; Dmitry Fursa [1]; Igor Bray [1]; Liam Scarlett [1]; Mark Zammit [3]; Starsha Odelia [1]

[1] *Curtin University*

[2] *NIST*

[3] *LANL*

The molecular convergent close coupling method was applied to study the ionisation of molecular hydrogen and its isotopologues from various electronic states. Vibrationally-resolved cross sections are presented and compared with data from literature.

Poster session / **571**

On the query complexity of connectivity with global queries

Authors: Arinta Auza[None]; Troy Lee[1]

[1] *University of Technology Sydney*

We study the query complexity of determining if a graph is connected with global queries. By following the template of l0-samplers, we construct quantum algorithms solving graph connectivity in several global query models.

Poster session / **572**

Suppressing stimulated Brillouin scattering and speckle effects by adjusting the seed laser wavefront in a high-power multi-mode fibre amplifier system

Author: Ori Henderson-Sapir[1]

Co-authors: Shuen Wei [2]; Linh Nguyen [3]; Stephen Warren-Smith [3]; Erik Schartner [2]; Heike Ebendorff-Heidepriem [2]; David Ottaway [2]

[1] *University of Adelaide*

[2] *The University of Adelaide*

[3] *University of South Australia*

We investigate wavefront shaping in a multi-mode fibre amplifier to achieve simultaneous suppression of SBS while maintaining a high output beam quality

Conference on Optoelectronic and Microelectronic Materials and Devices / **573**

UV emission from lanthanide-doped upconversion nanoparticles could promote cell damage in super-resolution microscopy

Author: Afshin Karami[1]

Co-authors: Thomas J. de Prinse [2]; Stephen Kidd [3]; Christopher J. Sumby [4]; Jingxiu Bi [1]

[1] *School of Chemical Engineering and Advanced Materials, The University of Adelaide, Adelaide, SA, 5005, Australia*

[2] *Institute for Photonics and Advanced Sensing (IPAS), School of Physical Sciences, The University of Adelaide, Adelaide, 5005, Australia*

[3] *Australian Centre for Antimicrobial Resistance Ecology, Research Centre for Infectious Disease, School of Biological Sciences, The University of Adelaide, Adelaide, 5005, Australia*

[4] *Department of Chemistry and Centre for Advanced Nanomaterials, The University of Adelaide, Adelaide, 5005, Australia*

UV emission from lanthanide-doped upconversion nanoparticles could promotes cell damage in super-resolution microscopy (details in the attached PDF file)

AIP: Condensed Matter, Materials and Surface Physics / **574**

New insulating and superconducting states in metal-organic frameworks and covalent organic frameworks

Authors: Ben Powell[1]; Henry Nourse[2]; Ross McKenzie[1]

[1] *UQ*

[2] *OIST*

See attached abstract

7th International Workshop on Speciality Optical Fibres / **575**

Fiber Based Polarization Insensitive Optical Coherence Tomography System

Author: Kandeel Mukhtar[1]

Co-authors: David McClelland [1]; Geoff Campbell [1]; Roland Fleddermann [1]

[1] *Australian National University*

A fiber based polarization insensitive OCT has been developed to remove polarization artefacts from conventional OCT images. The computational processing and hardware system calibrations will be discussed. A comparison of different polarization independent schemes and results will also be presented.

Poster session / **577**

Formation of Superconducting Thin Films and Devices in Silicon Via Phase-Transformation Processes Involving Aluminum or Vanadium

Author: Fshatsion Berhane Gessesew[1]

Co-authors: Manjith Bose [1]; Shao Qi Lim [2]; Fei Hu ; Brett Johnson [3]; Jeffrey McCallum [4]

[1] *The University of Melbourne*

[2] *Centre of Quantum Computation and Communication Technology, School of Physics, University of Melbourne*

[3] *RMIT*

[4] *Centre of Excellence for Quantum Computation and Communication Technology, School of Physics, University of Melbourne, Victoria 3010, Australia*

We report the formation of superconducting thin films and devices in phase-transformed Al-Si alloy and vanadium silicide (V_3Si) and present results of structural and electrical characterization studies and discuss the merits of these superconducting systems for novel devices in silicon.

AIP: Condensed Matter, Materials and Surface Physics / **578**

Modelling quantum dot structures in electromagnetic fields

Author: Hugh Sullivan[1]

Co-author: Jared Cole

[1] *RMIT University*

Using the finite-element method, we study the response of quantum dots of various geometries in electromagnetic fields. We demonstrate a general approach that supports the design and study of novel optical nanostructures.

Australian and New Zealand Conference on Optics and Photonics / **579**

Designer glasses for ultra-low loss optical waveguides for lightwave circuits

Author: TONEY teddy fernandez[1]

Co-authors: Andrew Ross-Adams [1]; Mark Bakovic [1]; Michael Withford [1]; Simon Gross [1]

[1] *Macquarie University*

A newly designed optical glass that could host ultra-low loss optical waveguides written with femtosecond laser is presented. Propagation losses as low as 0.05 dB/cm is reported for 1310 and 1550 nm wavelengths.

Poster session / **580**

Structure and Stability of the Nitrogen-Terminated Diamond Surface

Author: Daniel Roberts[1]

Co-authors: Alastair Stacey [2]; Brant C. Gibson [2]; Christian van Engers [1]; James Belcourt [1]; Santiago Corujeira-Gallo [3]

[1] *School of Science, RMIT University*

[2] *Australian Research Council Centre of Excellence for Nanoscale Biophotonics, RMIT University*

[3] *Quantum Brilliance Pty Ltd*

Plasma-driven epitaxy on nitrogen-terminated diamond can create very thin nitrogen-vacancy center layers, useful for quantum sensing. To reduce nitrogen loss during epitaxy, we study the stability of the nitrogen termination in these growth plasmas.

AIP: Group for Astroparticle Physics / Astronomy / 581

Development of a prototype direction sensitive dark matter detector

Author: Lachlan McKie[1]

Co-authors: Ferdos Dastgiri ; Gregory Lane [1]; Lindsey Bignell ; Peter Charles Mcnamara ; Zuzana Slavkovska [2]

[1] *Australian National University*

[2] *ANU*

Direction sensitive detectors are a potential solution to continue the dark matter search into the neutrino fog. The CYGNUS-1 detector is a prototype Time Projection Chamber developed at ANU, to inform future large scale directional dark matter searches.

Poster session / 582

Fabrication and Characterization of Superconducting High-fluence Ga-implanted and In-implanted Silicon Thin Films

Author: Fei Hu[None]

Co-authors: Manjith Bose [1]; Shao Qi Lim [2]; Fshatsion Berhane Gessesew [1]; Brett Johnson ; Jeffrey McCallum [3]

[1] *The University of Melbourne*

[2] *Centre of Quantum Computation and Communication Technology, School of Physics, University of Melbourne*

[3] *Centre of Excellence for Quantum Computation and Communication Technology, School of Physics, University of Melbourne, Victoria 3010, Australia*

In this work, we explore better ways to fabricate superconducting nanometre-thick high-fluence indium and gallium implanted SOI films. We provide structural and electrical measurements of these devices in preparation for fabricating patterned devices which may be used for quantum technologies.

Poster session / **583**

Quantum Diamond Magnetometers for Precision Vector Magnetic Field Sensing

Author: David Simpson[None]

Co-authors: Adam Silvester [1]; Anand Sivamalaib [1]; Andrew Greentree [2]; Andy Sayers [1]; Brant C. Gibson [3]; Chris Lew ; Fernando Meneses [4]; Liam Anderson [1]; Liam Hall [5]; Lloyd Hollenberg [6]

[1] *Phasor Innovation*

[2] *RMIT University*

[3] *Australian Research Council Centre of Excellence for Nanoscale Biophotonics, RMIT University*

[4] *School of Physics, University of Melbourne, VIC 3010, Australia*

[5] *School of Chemistry, the University of Melbourne*

[6] *The University of Melbourne*

Here we describe our work on the development of a precision vector quantum diamond magnetometer (QDM). We will also discuss future opportunities for engineering quantum-grade diamond materials for precision magnetometry applications here in Australia.

AIP: Group for Astroparticle Physics / Astronomy / **584**

Neutrino Astronomy and Astroparticle Physics with IceCube

Author: Gary Hill[1]

[1] *University of Adelaide*

In this contribution we discuss the IceCube Neutrino Observatory's discovery of high energy neutrino sources and plans for future upgrades of the detector.

Poster session / **585**

Trace detection of long-lived noble gas isotopes with Atom Trap Trace Analysis

Author: Rohan Glover[1]

Co-authors: Alec Deslandes [2]; Andre Luiten [3]; Axel Suckow [2]; Christoph Gerber [2]; Dirk Mallants [2]; Phillip Light [1]; Thomas Chambers [3]

[1] *The University of Adelaide*

[2] *CSIRO*

[3] *University of Adelaide*

We report progress towards trace detection of the noble gas isotope ^{39}Ar at the Australian Atom Trap Trace Analysis facility. Argon-39 has a natural abundance $^{39}\mathrm{Ar}/\mathrm{Ar} = 8\times10^{-16}$ and half-life of 269yrs making it useful for radiometric dating on an anthropogenic timescale.

Poster session / **586**

Towards an Australia IACT Array in a Network of Cherenkov Telescopes

Authors: Gavin Rowell[None]; Sabrina Einecke[1]; Simon Lee[None]

[1] *University of Adelaide*

Small arrays of Imaging Air Cherenkov Telescopes were simulated to study the potential performance of an Australia-sited array, which would contribute to achieving 24-hour all-sky coverage at GeV and TeV energies.

Poster session / **587**

New developments in the transcorrelated method for multicomponent quantum gases

Author: Chris Bradly[None]

We report results for the transcorrelated method applied to multicomponent quantum gases. We discuss applications of our methods to few atom systems that are achievable in experimental setups, as well as to liquid droplets and heavy impurities in quantum gases.

AIP: Nuclear and Particle Physics / **588**

Searches for Supersymmetric BSM particles via Strong Production at ATLAS

Author: Tristan Andrew Ruggeri[1]

[1] *University of Adelaide (AU)*

In this talk I will present the general strategies and challenges of Strong production SUSY searches, and mention the novel tools and techniques that have been developed to enhance these searches.

Australian and New Zealand Conference on Optics and Photonics / **589**

Three-dimensional characterisation of cellular elasticity using quantitative micro elastography

Authors: Matt Hepburn[1]; Alireza Mowla[1]; Jiayue Li[1]; Samuel Maher[1]; Danielle Vahala[1]; Sebastian Amos[1]; Farzan Navaeipour[1]; Yu Suk Choi[1]; Brendan Kennedy[1]

[1] *The University of Western Australia*

The elasticity of cells and their environment are critical regulators of cell functions. In this work, we present the development of quantitative micro-elastography to characterise the elasticity of cells and cell spheroids in 3-D biomaterials.

AIP: Quantum Science and Technology / 590

Optimal scaling quantum linear systems solver via discrete adiabatic theorem

Authors: Dominic Berry[1]; Pedro C.S. Costa[1]

Co-authors: Dong An [2]; Ryan Babbush [3]; Yuan Su [3]; Yuval Sanders [4]

[1] *Macquarie University*

[2] *Maryland University*

[3] *Google*

[4] *University of Technology Sydney*

We prove a rigorous form of the adiabatic theorem for a discrete time evolutions. We use this discrete theorem to develop a quantum algorithm for solving linear systems that matches the known lower bound on the complexity of κ.

AIP: Nuclear and Particle Physics / 591

Dense Nuclear Matter with Bag Overlap

Author: Jesper Leong[None]

Co-authors: Anthony Thomas [1]; Pierre Guichon ; Theo Motta

[1] *University of Adelaide*

Possible new physics is incorporated into the QMC energy density is shown to be capable of predicting a neutron star mass of 2.1 $M_\odot$ without changing the symmetric nuclear matter properties at saturation density.

Australian and New Zealand Conference on Optics and Photonics / 592

3D Dynamic Tuning of Metasurfaces

Author: Yana Izdebskaya[1]

[1] *Australian National University*

We demonstrate fully three-dimensional (3D) active tuning of dielectric metasurfaces integrated with liquid crystals and dynamically controlled by magnetic field. Our approach entails good promise for highly tunable optical metadevices.

Poster session / 593

Quantum transduction with atomic three-level systems

Author: Thomas Smith[1]

Co-author: Andrew Doherty [1]

[1] *University of Sydney*

We investigate a scheme for microwave-to-optical transduction using atomic three-level systems. Using quasi-degenerate perturbation theory we derive an effective Hamiltonian description for the conversion process. We find that the conversion is limited by off-resonant effects like unintended biphoton emission.

Poster session / **594**

Superconducting Gallium-Hyperdoped Germanium from Pulsed-Laser Melting

Authors: Shao Qi Lim[1]; Manjith Bose[2]

Co-authors: Angela Tanesha [3]; Pietro Argenton [4]; Daniel Creedon [2]; Brett Johnson [5]; Enrico Napolitani [4]; Jeffrey McCallum [6]

[1] *Centre of Quantum Computation and Communication Technology, School of Physics, University of Melbourne*

[2] *The University of Melbourne*

[3] *School of Physics, The University of Melbourne*

[4] *Dipartimento di Fisica e Astronomia 'Galileo Galilei', Universia di Padova, 35131 Padova, Italy.*

[5] *RMIT*

[6] *Centre of Excellence for Quantum Computation and Communication Technology, School of Physics, University of Melbourne, Victoria 3010, Australia*

Ga-hyperdoped germanium fabricated from ion implantation and flash lamp annealing has been shown to be superconducting at low temperatures of ~0.5 K. Here, we fabricate Ga-hyperdoped germanium from GeGa deposition and pulsed-laser melting and obtain a Tc of ~0.86 K.

Poster session / **595**

Efficient multiqubit characterization and control via finite-frame filter functions

Authors: Diego Bernal Garcia[1]; Gerardo Paz-Silva[1]

[1] *Griffith University*

We demonstrate that using the framework of finite-frame filter functions the cost required for high-quality multiqubit characterization and control is significantly lower than what is expected using the standard frequency-domain filter-function formalism.

Poster session / **596**

Femtosecond Laser Written Achromatic Phase Shifters

Author: Glen Douglass[1]

Co-authors: Barnaby Norris ; Elizabeth Arcadi ; Marc-Antoine Martinod ; Michael Withford [1]; Olivier Guyon ; Peter tuthill ; Simon Gross [1]; Teresa Klinner-Teo

[1] *Macquarie University*

This paper covers the design of achromatic phase shifters using differential waveguide dispersion. These devices are then fabrication using the femtosecond laser direct write technique.

AIP: Condensed Matter, Materials and Surface Physics / 597

Magnetic Raman scattering in quasi-one-dimensional antiferromagnets

Author: Oliver Bellwood[1]

Co-authors: Ben Powell ; Henry Nourse [2]

[1] *The University of Queensland*

[2] *OIST*

We derive the magnetic Raman intensity of weakly coupled Heisenberg chains using perturbation theory and the Bethe ansatz. An intensity peak that corresponds to the enhanced scattering of two triplon excitations is identified.

AIP: Quantum Science and Technology / 598

An Optimised Spin Readout Scheme for Quantum Sensors Based on Nitrogen Vacancy Centres in Diamond

Author: Di Wang[1]

Co-authors: Sepehr Ahmadi [2]; Ella Walsh [3]; Fernando Meneses [4]; Anthony Chesman [5]; David Simpson ; Liam Hall [6]

[1] *University of Melbourne*

[2] *CSIRO*

[3] *The University of Melbourne*

[4] *School of Physics, University of Melbourne, VIC 3010, Australia*

[5] *CSIRO Manufacturing*

[6] *School of Chemistry, the University of Melbourne*

We investigate the photo-physics of the nitrogen vacancy centre to improve the optical readout fidelity by designing a new decomposition technique to extract spin state information.

Poster session / 599

Spectroscopy to observe Maxwell's Demon

Author: Rose Manakil[None]

Co-authors: Erik Streed [1]; Joan Vaccaro [2]

[1] *Griffith unversity*

[2] *Griffith University*

To observe Maxwell's demon in our trapped Yb ion proof-of-concept experiment, a high finesse, high absolute transmission efficiency Fabry-Perot optical cavity is being developed to resolve < MHz scale shifts of single photons.

AIP: Quantum Science and Technology / 600

Towards compact quantum diamond nuclear magnetic resonance spectrometers

Author: Sepehr Ahmadi[None]

Co-authors: Anthony Chesman [1]; David Simpson ; Di Wang [2]; Ella Walsh ; Liam Hall [3]

[1] *CSIRO Manufacturing*

[2] *University of Melbourne*

[3] *School of Chemistry, the University of Melbourne*

We measure NMR signals via their modulation of the NV spin-state dependent red photoluminescence intensity using a time-resolved quantum heterodyne detection scheme.

Precision and Quantum Sensing Workshop / 601

A laser-cooled optical beam clock for portable applications

Author: Rachel Offer[None]

Co-authors: Andre Luiten [1]; Ashby Hilton [1]; Elizaveta Klantsataya [1]; Nicolas Bourbeau Hebert [1]

[1] *University of Adelaide*

We demonstrate the first measurement of the 10-mHz wide ytterbium clock transition to be made on an atomic beam, and report on the development of a portable optical atomic clock based on this technique.

Poster session / 602

Preferential coupling of NV nanodiamond to doped fibre and spliced SMF

Author: Shuo Li[1]

Co-authors: Andrew Greentree [1]; Brant Gibson [1]; David Simpson [2]; Dongbi Bai [1]; Heike Ebendorff-Heidepriem [3]; Marco Capelli [4]; Scott Foster [5]; Shahraam Afshar Vahid [6]; Wenqi Zhang [7]

[1] *ARC Centre of Excellence for Nanoscale BioPhotonics, RMIT University*

[2] *School of Physics, The University of Melbourne*

[3] *University of Adelaide*

[4] *Australian Research Council Centre of Excellence for Nanoscale Biophotonics, RMIT University*

[5] *Defence Science and Technology Group*

[6] *Laser Physics and Photonic Devices Laboratories, University of South Australia, SA 5095, Australia*

[7] *Laser Physics and Photonic Devices Laboratories, School of Engineering, University of South Australia*

We have investigated the preferential coupling of the nanodiamond into the guided-modes of a step-index fibre. To explore the possibility of long-distance magnetic field sensing we have also modelled the coupling efficiency of splicing diamond-doped fibres to commercial SMF-28e fibres.

Precision and Quantum Sensing Workshop / 603

Diamond-based Quantum Sensors for Next Generation NMR Applications

Author: Liam Hall[1]

Co-authors: Anthony Chesman [2]; David Simpson ; Di Wang [3]; Ella Walsh [4]; Sepehr Ahmadi [5]

[1] *School of Chemistry, the University of Melbourne*

[2] *CSIRO Manufacturing*

[3] *University of Melbourne*

[4] *The University of Melbourne*

[5] *CSIRO*

We discuss our recent progress in utilising cutting edge diamond-based quantum sensors to develop a portable, robust, and sensitive nuclear magnetic resonance (NMR) spectrometer for in-field trace chemical detection and analysis.

Poster session / 604

Benchmarking in Encoded Magic State Injection

Authors: Nicholas Fazio[1]; Robin Harper[1]; Stephen Bartlett[1]

[1] *The University of Sydney*

We investigate how physical noise is transformed and suppressed in encoded magic state injection schemes. These circuits are key to NISQ computation and classifying their error on current devices will identify problems that larger, scaled up architectures must address.

Precision and Quantum Sensing Workshop / 605

Quantum Spectral Analysis by Landau-Zener Transitions

Author: Christopher Bounds[1]

Co-authors: Alex Tritt [1]; Hamish Taylor [1]; Josh Duff [1]; Lincoln Turner [1]

[1] *School of Physics and Astronomy, Monash University*

We realise a novel quantum sensing protocol for spectral analysis, utilising continuous Faraday measurement of an ultracold atomic ensemble's quantum state. Through quantum process tomography, signal parameters are retrieved from the characteristic transition driven as the sensor sweeps through resonance.

Poster session / **606**

Information Flow in Non-Unitary Quantum Cellular Automata

Author: Elisabeth Wagner[1]

Co-authors: Ramil Nigmatullin [1]; Alexei Gilchrist [1]; Gavin Brennen [1]

[1] *Macquarie University*

We propose a new measure of information flow in non-unitary quantum cellular automata which defines an equivalence class of open quantum systems that are coupled to an environment and are invariant in time and space.

Poster session / **607**

Collisional-model quantum trajectories for entangled qubit environments

Authors: Shakib Daryanoosh[1]; Alexei Gilchrist[None]; Ben Baragiola[2]

[1] *Dept. of Physics, University of Western Australia*

[2] *Centre for Quantum Computation and Communication Technology, School of Science, RMIT University, Melbourne, VIC 3000, Australia*

PDF included

Conference on Optoelectronic and Microelectronic Materials and Devices / **608**

Controllable Fabrication of Blue Quantum Emitters in Hexagonal Boron Nitride

Author: Angus Gale[None]

This work presents a precise technique to control fabrication of quantum emitters in hexagonal boron nitride (hBN) via electron irradiation. An annealing procedure for increased efficiency and link to well documented UV defect emission in hBN is also outlined.

AIP: Group for Astroparticle Physics / Astronomy / **609**

Modelling the Gamma-ray Morphology of the Supernova Remnant W28

Author: Sabrina Einecke[1]

Co-author: Gavin Rowell

[1] *University of Adelaide*

This contribution will introduce a novel 3D modelling and present the gamma-ray morphology around the SNR W28 using hydrogen gas distributions from Australian surveys. We will discuss our grid search of SNR, diffusion and gas properties to reproduce gamma-ray observations.

7th International Workshop on Speciality Optical Fibres / 610

Simultaneous beam shaping and suppression of simulated Brillouin scattering by adjusting the input wavefront in a multimode fiber

Authors: SHUEN WEI[1]; Ori Henderson-Sapir[1]; Stephen C. Warren-Smith[2]; Erik Schartner[1]; David Ottaway[1]; Heike Ebendorff-Heidepriem[1]; Linh V. Nguyen[2]

[1] *University of Adelaide*

[2] *University of Adelaide; University of South Australia*

We experimentally demonstrate that adjusting the input wavefront of a multimode fiber can be used to simultaneously shape beam and suppress simulated Brillouin scattering (SBS) for a high-power narrow linewidth system.

Australian and New Zealand Conference on Optics and Photonics / 611

Development of Western Australia's Optical Space Communications Capabilities

Authors: Benjamin Dix-Matthews[1]; Shane Walsh[1]

Co-authors: Alex Frost [1]; Ayden McCann [1]; Charles Gravestock [1]; David Gozzard [1]; Kevin Choung [1]; Mike Kriele [1]; Sascha Schediwy [1]; Skevos Karpathakis [1]

[1] *The University of Western Australia*

An overview of the free-space optical communications research being conducted at UWA, with emphasis on the development of the Western Australian Optical Ground Station and results from field tests with a deployable mobile optical terminal.

7th International Workshop on Speciality Optical Fibres / 613

Development of components and processes for power scaling of diode-pumped metal coated optical fibre amplifiers

Authors: Adam Gambell[1]; Alexander Hemming[1]; Jonathan Keane[2]; Nikita Simakov[1]; Robert Swain[2]

[1] *DST Group*

[2] *Submicron Engineering*

We have demonstrated a 6+1⟶1 optical fibre combiner for diode-pumped 1 μm operation, using metal coated fibre for the output fibre port with pump power levels up to 700 W

Australian and New Zealand Conference on Optics and Photonics / 614

Integratable 3D Printed Terahertz Horn Coupler

Author: Qigejian Wang[1]

Co-authors: Boris Kuhlmey [2]; Daniyal Ali [1]; Haisu Li [3]; Shaghik Atakaramians [1]

[1] *UNSW Sydney*

[2] *School of Physics, The University of Sydney*

[3] *Institute of Lightwave Technology, Beijing Jiaotong University*

We design and demonstrate a 3D-printed horn coupler, improving the transmittance of a hybrid photonic crystal waveguide by more than 20dB, providing a convenient and economical way of customizing couplers for different waveguides and could be integrated in terahertz devices.

Poster session / 615

Next-Gen Tricoupler Device for Exoplanet Detection

Author: Elizabeth Arcadi[None]

Co-authors: Barnaby Norris ; Glen Douglass [1]; Jacinda Webb [1]; Marc-Antoine Martinod ; Michael Withford [1]; Olivier Guyon ; Peter tuthill ; Simon Gross [1]; Teresa Klinner-Teo

[1] *Macquarie University*

Tricouplers can be utilised for nulling interferometry. We present laboratory characterisation of 3D tricouplers fabricated by ultrafast laser inscription as well as numerical solutions to coupled mode equations providing a parameter scan to optimise fabrication.

AIP: Condensed Matter, Materials and Surface Physics / 616

Understanding the complex magnetic effects in a low-dimensional frustrated magnet through various experimental and theoretical techniques

Author: Jackson Allen[1]

Co-authors: Andrew Studer [2]; Joseph Horvat [3]; Kirrily Rule [4]; Leonie Heinze [5]; Richard Mole [6]; Roger Lewis [3]; Stefan Suellow [5]; Thomas Sanders [3]

[1] *University of Wollongong / ANSTO*

[2] *Australian Centre for Neutron Scattering, Australian Nuclear Science and Technology Organisation*

[3] *University of Wollongong*

[4] *ANSTO*

[5] *Technische Universität Braunschweig*

[6] *ACNS, ANSTO*

Atacamite is a frustrated quantum magnet, a class of materials which often exhibit exotic magnetic phases. The magnetic characteristics of atacamite have been investigated through various experimental and theoretical techniques. These will be discussed and compared.

Poster session / **617**

Determination of Transition Polarisability for Atomic Parity Violation in Cesium

Author: Jayden Hasted[1]

Co-authors: Benjamin Roberts ; Carter Fairhall [1]; Jacinda Ginges

[1] *The University of Queensland*

Determination of transition polarisability for atomic parity violation in cesium.

Australian and New Zealand Conference on Optics and Photonics / **618**

Development of a Compact Clock for Small Satellite Applications

Author: Emily Ahern[None]

Co-authors: Andre Luiten [1]; Christopher Perrella [1]; Clayton Locke [1]; Nicolas Bourbeau Hebert [1]; Sarah Scholten [2]

[1] *University of Adelaide*

[2] *Institute for Photonics and Advanced Sensing, University of Adelaide*

We report upon a prototype optical clock using a two-colour two-photon transition in Rubidium, toward developing a compact alternative for the next generation GNSS.

Precision and Quantum Sensing Workshop / **619**

Towards single-shot waveform magnetometery via quantum compressive sensors

Author: Alexander Tritt[None]

Co-authors: Christopher Bounds [1]; Hamish Taylor [1]; James Saunderson [2]; Joshua Morris [1]; Lincoln Turner [1]

[1] *School of Physics & Astronomy, Monash University, Victoria 3800, Australia.*

[2] *Department of Electrical and Computer Systems Engineering, Monash University, Victoria 3800, Australia.*

We experimentally demonstrate a quantum compressive waveform sensor. We reconstruct a synthesised neural magnetic waveform using an incomplete set of frequency measurements made by radio frequency dressed atoms. Reconstruction is achieved via convex optimisation.

AIP: Condensed Matter, Materials and Surface Physics / 620

Optical voltage imaging with charge-coupled fluorescence of diamond colour-centres.

Author: Nikolai Dontschuk[None]

Co-authors: Alastair Stacey [1]; Charlie Pattinson [2]; Daniel McCloskey [2]; David Simpson ; Hunter Johnson [3]

[1] *RMIT University*

[2] *The University of Melbourne*

[3] *The University of Melbourne School of Physics*

Color center charge state specific fluorescence has the potential to be a powerful new tool for investigate the electrical response of biological systems. In this talk I will describe development and advantages of this technique.

7th International Workshop on Speciality Optical Fibres / 621

Machine Learning for Pressure Sensing Using Pure Silica Microstructured Optical Fiber Based Specklegram Sensor

Author: Mohammad Istiaque Reja[1]

Co-authors: Darcy L. Smith [2]; Linh V. Nguyen [2]; Heike Ebendorff-Heidepriem [3]; Stephen C. Warren-smith [2]

[1] *Institute for Photonics and Advanced Sensing, School of Physical Sciences, The University of Adelaide, Adelaide, SA 5005, Australia, Dept. of Electrical and Electronic Engineering, Chittagong University of Engineering and Technology, Chattogram 4349, Bangladesh, and Future Industries Institute, University of South Australia, Mawson Lakes, SA 5095, Australia.*

[2] *Institute for Photonics and Advanced Sensing, School of Physical Sciences, The University of Adelaide, Adelaide, SA 5005, Australia and Future Industries Institute, University of South Australia, Mawson Lakes, SA 5095, Australia.*

[3] *Institute for Photonics and Advanced Sensing, School of Physical Sciences, The University of Adelaide, Adelaide, SA 5005, Australia*

We demonstrate the application of machine learning to improve the performance of specklegram pressure sensor using pure silica six-hole microstructured optical fiber. The sensor will be useful for pressure sensing in harsh industrial applications.

Poster session / 622

Towards High-Temperature Light-Induced Spin State Trapping: Insights From the Crystal Field Theory and Molecular Dynamics

Authors: Ben Powell[None]; Muhammad Nadeem[1]

[1] *The University of Queensland*

We introduce a semi-empirical microscopic model of spin crossover materials combining crystal field theory with elastic intermolecular interactions. We investigate the interplay of single site and collective physics of SCO materials. We demonstrate a realistic route to room temperature switching.

AIP: Nuclear and Particle Physics / 623

Searches for Long-Lived Particles using Displaced Vertices and Missing Transverse Energy at the ATLAS Detector

Author: Emily Filmer[1]

[1] *University of Adelaide (AU)*

Long Lived Particles are predicted in many BSM models. This is an overview of previous analyses to highlight where missing energy, with additional data may be more sensitive to SUSY signals, or to help set limits on supersymmetric particle masses.

Poster session / 624

Inter-laboratory comparisons in support of the development of standards for 2D materials

Author: Malcolm Lawn[1]

Co-authors: Asa Jamting [1]; Bakir Babic [1]; Victoria Coleman [1]

[1] *National Measurement Institute Australia*

NMI participates in international inter-laboratory comparisons (ILCs) supporting development of standards for graphene and 2D materials. This presentation highlights the technical challenges of the accurate measurement and characterisation of these materials with Atomic Force Microscopy.

Precision and Quantum Sensing Workshop / 625

Progress Towards Quantum-Enhanced Atomic Gravimetry

Author: Simon Haine[None]

Atom interferometry currently provides state-of-the art sensitivity for measurements of gravity. However, shot-noise inherently limits the sensitivity and bandwidth.We propose and theoretically model a scheme capable of generating entanglement which is compatible with high-precision atomic gravimeters.

Australian and New Zealand Conference on Optics and Photonics / 626

Optical bonding fibers to ZBLAN glass chip waveguides using a CO2 laser

Author: Yongsop Hwang[1]

Co-author: David Lancaster [1]

[1] *University of South Australia*

We report the successful thermal fusing of silica single-mode fibers directly to depressed cladding waveguides inscribed in a ZBLAN glass chip using a CO2 laser. This fusing enables complete integration of a fiber and bulk glass waveguides.

Poster session / **627**

Simulation of the ATLAS Inner Tracker

Author: Emily Filmer[1]

[1] *University of Adelaide (AU)*

The High-Luminosity Large Hadron Collider is due to come online sometime in 2028, posing new challenges to the ATLAS detector. The new Inner Tracker is simulated to check hardware and software expectations are met and understood.

Precision and Quantum Sensing Workshop / **628**

Unambiguous measurement of DC field in a cold atom magnetometer with sensitivity below 1 pT/rHz

Author: Hamish Taylor[1]

Co-authors: Alex Tritt [1]; Chris Bounds [1]; Lincoln Turner [1]

[1] *Monash University*

We describe a measurement and reconstruction method for performing optical magnetometry in an ultracold atomic vapour, making use of Hilbert transform-based FM demodulation to perform instantaneous retrieval of the Larmor phase and allowing calibration-free measurement of the field.

Poster session / **629**

Regenerated Polymer Optical Fibre Bragg Gratings for Cochlear Implantation

Author: Dinusha Gunawardena[1]

Co-authors: Xin Cheng [1]; Jingxian Cui ; Linyue Lu [1]; Arvind Vadivelu [2]; Geraldi Edbert ; Bernard Chen [2]; Denny Oetomo [2]; Stephen O'Leary [2]; Hwa-Yaw Tam [1]

[1] *The Hong Kong Polytechnic University*

[2] *University of Melbourne*

High temperature sustainability of a new class of Bragg gratings referred to as regenerated polymer optical fiber Bragg gratings (RPOFBGs) in ZEONEX-based polymeric fibers are explored and integrated with cochlear implants to aid surgical navigation.

AIP: Condensed Matter, Materials and Surface Physics / 630

Introducing the Pair-Angle Distribution Function: many-atom statistics of crystals and disordered materials

Author: Andrew Martin[1]

Co-authors: Jack Binns [1]; Patrick Adams [1]; Stefan Paporakis [1]; Michael Hassett [1]; Tamar Greaves [1]

[1] *RMIT University*

The pair-angle distribution function (PADF) is a multi-atom distribution of atomic structure that can be directly measured with x-ray or electron scattering. It enables, for example, direct bond-angle distribution measurements and has wide applicability at the nanoscale.

Poster session / 631

Phase-space stochastic quantum hydrodynamics for interacting Bose gases

Authors: Steven Simmons[1]; Jason Pillay[1]; Karen Kheruntsyan[None]

[1] *The University of Queensland*

We derive a new stochastic hydrodynamic approach for the description of interacting Bose gases that is capable of computing non-equilibrium quantum correlations, even for short-wavelength phenomena. We perform such calculations in quantum shock wave scenarios.

7th International Workshop on Speciality Optical Fibres / 632

Large Range Torsion Sensor Based on Twin-Core Polymeric Optical Fibre

Author: Jingxian Cui[1]

Co-authors: Dinusha Gunawardena [1]; Hwa-Yaw Tam [1]; Xin Cheng [1]

[1] *The Hong Kong Polytechnic University*

We propose a torsion sensor using an FBG-based twin-core ZEONEX polymeric fiber, with a measurement range up to ±360°. Due to the central/side core arrangement, torsion can be retrieved independently from axial strain and temperature.

7th International Workshop on Speciality Optical Fibres / 633

Polymer Fiber Bragg Grating-embedded Artificial Skin for Tactile Force Detection and Contact Localization of Robotic Fingers

Author: Chern Yang Leong[1]

Co-authors: Dinusha Gunawardena [1]; Xin Cheng [1]; Jingxian Cui [1]; Hwa-Yaw Tam [1]

[1] *The Hong Kong Polytechnic University*

A tactile sensitive silicone-based artificial skin is fabricated on a fingertip model with embedded ZEONEX-based polymer Bragg gratings. Through tactile force feedback and the aid of machine learning, contact localization throughout the fingertip is achieved.

Australian and New Zealand Conference on Optics and Photonics / 634

Developing Optical Phased Array sensing for the Breakthrough Starshot propulsion system

Author: Paul Sibley[None]

Co-authors: Chathura Bandutunga [1]; Michael Ireland [1]

[1] *Australian National University*

We present the key considerations in our design for using optical interferometry to phase-lock optical phased arrays with up to 100 million emitters, needed for the ambitious proposed Breakthrough Starshot mission.

Precision and Quantum Sensing Workshop / 635

Coupled Photonic Resonators for High-Performance Optomechanical Sensors

Authors: Benjamin Carey[1]; Fernando Gotardo[None]; Glen Harris[1]; James Bennett[2]; Warwick Bowen[1]

[1] *The University of Queensland*

[2] *Griffith University*

We present the use of non-degenerate coupled photonic cavities in order suppress the contribution of laser phase noise in optomechanical sensing Systems. These coupled Cavities demonstrate laser phase noise rejection whilst not significantly degrading the device's response.

AIP: Quantum Science and Technology / 636

A quantum spin heat engine with trapped Yb^+ ions

Author: Liam McClelland[None]

Co-authors: Erik Streed [1]; Joan Vaccaro [2]; Mark Baker

[1] *Griffith unversity*

[2] *Griffith University*

The first steps towards a proof-of-concept memory powered heat engine using trapped $^{171}Yb^{+}$ ions. This proof-of-concept intends on showing entropy transfer between thermal and spin reservoirs with minimal energy loss, therefore allowing a higher efficiency heat engine than allowed classically.

Poster session / **637**

Dielectric Metasurfaces Based Polarimetry for Satellite Imaging

Author: Sarah Dean[1]

Co-authors: Andrey Sukhorukov ; Dragomir Neshev [2]; Neuton Li ; Robert Sharp [1]

[1] *The Australian National University*

[2] *Australian National University*

We present a topology-optimised metasurface design for ultra-compact and light-weight space-based polarimetry, allowing for five parallel polarisation measurements across the moving image strip, to facilitate applications including water glint removal.

AIP: Theoretical and Mathematical / **638**

Surface gravity and information loss

Author: Sebastian Murk[1]

Co-authors: Robert B. Mann [2]; Daniel R. Terno [3]

[1] *Macquarie University and Sydney Quantum Academy*

[2] *University of Waterloo and Perimeter Institute for Theoretical Physics*

[3] *Macquarie University*

Information loss in black hole evolution is one of the longest-running controversies in theoretical physics. However, the discordant properties of different generalisations of surface gravity reveal that the problem cannot be formulated self-consistently in semiclassical gravity.

Precision and Quantum Sensing Workshop / **639**

Isotopic enrichment of diamond for bulk nitrogen-vacancy magnetometry applications

Author: David Simpson[1]

Co-authors: Alastair Stacey [2]; Alister Chew ; Andrew Greentree [2]; Brant C. Gibson [3]; Christopher Lew [4]; Heike Ebendorff-Heidepriem [5]; Scott Foster [6]; Shahraam Afshar Vahid [7]

[1] *The University of Melbourne School of Physics*

[2] *RMIT University*

[3] *Australian Research Council Centre of Excellence for Nanoscale Biophotonics, RMIT University*

[4] *University of Melbourne*

[5] *H. Ebendorff-Heidepriem*

[6] *Defence Science and Technology Group*

[7] *Laser Physics and Photonic Devices Laboratories, University of South Australia, SA 5095, Australia*

In this work, we explore how isotopic enrichment of diamond materials can benefit quantum diamond magnetometers. This is implemented by engineering CVD-grown material and conducting characterization of their properties in order to evaluate the impact on their overall magnetic sensitivities.

AIP: Condensed Matter, Materials and Surface Physics / 640

Skyrmion nucleation on a surface of topological insulators

Author: Oleg Tretiakov[1]

[1] *UNSW*

Skyrmion nucleation induced by spin-transfer torques at an interface of a topological insulator and a ferromagnetic insulator is investigated. We find skyrmion nucleation time, critical nucleation field, and skyrmion numbers.

AIP: Theoretical and Mathematical / 641

Physical black holes in modified theories of gravity

Author: Sebastian Murk[1]

Co-author: Daniel R. Terno [2]

[1] *Macquarie University and Sydney Quantum Academy*

[2] *Macquarie University*

In spherical symmetry, only two classes of dynamic solutions to the semiclassical Einstein equations describe physical black holes, and their formation follows a unique scenario. To be compatible with their existence, modified gravity theories must satisfy several constraints.

AIP: Quantum Science and Technology / 642

Broadcast-based nonlocality activation for noisy quantum states

Author: Luis Villegas Aguilar[None]

Nonlocality is a paramount resource for quantum communications. In this experimental work, we aim to demonstrate, using single photons, the emergence of Bell nonlocality in quantum states that would be unable to display nonclassical behaviour in the standard Bell scenario.

Poster session / **643**

Two-dimensional oxide from surface of liquid chalcogen mixture

Author: Patjaree Aukarasereenont[1]

[1] *RMIT University*

Two-dimensional semiconducting oxide was synthesised via the developed liquid metal-based synthesis technique. The material has wide bandgap and exhibits p-type behaviours. The fabricated field-effect transistors showed impressive performances which render this material promising for electronics applications.

7th International Workshop on Speciality Optical Fibres / **644**

Remote magnetometry with fluorescent microdiamonds incorporated in optical fibres

Author: Marco Capelli[None]

Co-authors: Dongbi Bai [1]; Minh Hoa Huynh [2]; Wen Qi Zhang [3]; Shuo Li [1]; David Simpson ; Philipp Reineck ; Shahraam Afshar Vahid [4]; Andrew D. Greentree [5]; Scott Foster [6]; Heike Ebendorff-Heidepriem ; Brant C. Gibson [5]

[1] *RMIT University*

[2] *The University of Adelaide*

[3] *University of South Australia*

[4] *Laser Physics and Photonic Devices Laboratories, University of South Australia, SA 5095, Australia*

[5] *Australian Research Council Centre of Excellence for Nanoscale Biophotonics, RMIT University*

[6] *DSTG*

We developed an optical fibre containing fluorescent micron-sized diamonds. The nitrogen-vacancy defects inside diamonds make the fibre sensitive to external magnetic fields. I will discuss the fabrication process and the sensitivity we achieved.

Poster session / **645**

Integrated deflection measurement for electrostatically actuated MEMS

Author: Michal Zawierta[1]

Co-authors: Adrian Keating ; Dhirendra Kumar Tripathi [1]; Dilusha Silva [1]; Gino Putrino ; Hemendra Kala [1]; Lorenzo Faraone [1]; Mariusz Martyniuk

[1] *The University of Western Australia*

Modern surface micromachined optical MEMS commonly use electrostatic means to achieve mechanical actuation and often require a closed feedback loop to maximize tuning accuracy. Our method enables MEMS membrane displacement measurement without device modifications.

Poster session / **646**

Visualization of glass flow during extrusion to track glass deformations

Author: Anna Radionova[1]

Co-authors: Erik Schartner [2]; Heike Ebendorff-Heidepriem [1]

[1] *Institute for Photonics and Advanced Sensing (IPAS) & School of Physical Sciences, The University of Adelaide, Adelaide 5005, SA, Australia*

[2] *Institute for Photonics and Advanced Sensing (IPAS) & School of Physical Sciences, The University of Adelaide, Adelaide 5005, SA, Australia,School of Medicine, The University of Adelaide, Adelaide 5005, SA, Australia*

The paper reports an experimental method to visualize glass flow through an extrusion die. A soda-lime glass was used as the model glass for the visualization. The initial work used simple die designs to refine existing theoretical models.

AIP: Relativity and Gravitation / **647**

Horizon Singularities and Energy Momentum Tensor Classification

Author: Ioannis Soranidis[1]

Co-authors: Daniel R. Terno [1]; Sebastian Murk [1]; Pravin Dahal [1]

[1] *Macquarie University*

Physical black holes are considered to be trapped regions bounded by the apparent horizon. Even though assuming that semi-classical physics is valid and curvature is not diverging there, other things suggest that the apparent horizon is a mildly singular surface.

Precision and Quantum Sensing Workshop / **648**

Quantum-enabled super resolution imaging

Author: Larnii Booth[None]

Co-authors: Nicolas Mauranyapin ; Rumelo Amor [1]; Warwick Bowen [2]

[1] *Queensland Brain institute, University of Queenland*

[2] *The University of Queensland*

A super-resolution optical microscopy method using Bayesian inference and flipped optical modes, developed to better resolve point source emitters below the resolution limit.

Poster session / **650**

Anti-Resonant Reflecting Acoustic Rib Waveguides for Opto-acoustics

Authors: Michael Steel[1]; Mikolaj Schmidt[1]; Thomas Dinter[1]

[1] *MQ Photonics Research Centre, School of Mathematical and Physical Sciences, Macquarie University*

Mutual strong confinement of light and sound in photonic waveguides is desirable for on-chip opto-acoustic nonlinear interactions, but very few materials are naturally guiding for both waves. Here, we present Anti-Resonant Reflecting Acoustic Waveguides (ARRAWs) as a potential solution.

AIP: Atomic and Molecular Physics / 651

Exploring Quantum Magnetism and Many-Body Localisation in a Dilute Gas of Ultracold Polar Molecules

Authors: Matthew Davis[1]; Timothy Harris[1]

Co-authors: Andrew Groszek [1]; Arghavan Safavi-Naini [2]

[1] *The University of Queensland*

[2] *University of Amsterdam*

We investigate quantum spin systems realised in a dilute gas of ultracold polar molecules pinned in a deep optical lattice. We discuss a novel disorder mechanism for engineering many-body localisation, and explore the system's non-equilibrium dynamics in one and two-dimensions.

AIP: Atomic and Molecular Physics / 652

On the hyperfine anomaly and atomic parity violation

Authors: Benjamin Roberts[1]; Jacinda Ginges[None]

[1] *The University of Queensland*

Reporting on several of our recent works on the hyperfine anomaly and its importance in searches for new physics in precision atomic experiments.

Australian and New Zealand Conference on Optics and Photonics / 653

Optical Tweezers for IVF: an in vitro study of reproductive cells and their environment

Author: Carl Adrian Campugan[1]

Co-authors: Amanda Wright [2]; Erik Schartner [1]; Graham Bruce [3]; Kishan Dholakia [3]; Kylie Dunning [1]; Tania Mendonca [2]; Yoshihiko Arita [3]

[1] *University of Adelaide*

[2] *University of Nottingham*

[3] *University of St. Andrews*

Using optical tweezers for the better understanding of how the microrheology of reproductive cells and their local environment during *in vitro* procedures is correlated to embryo development, implantation success, pregnancy, and live birth.

Poster session / 654

Light Beam Induced Current and Electron Beam Induced Current measurements of Mercury Cadmium Telluride n-on-p photodetectors

Author: Daniel Morley[None]

Co-authors: Gilberto A. Umana-Membreno [1]; Hemendra Kala [2]; Renjie Gu [2]; Jarek Antoszewski [1]; Lorenzo Faraone [2]

[1] *University of Western Australia*

[2] *The University of Western Australia*

In this work we will present results of a LBIC and EBIC study of n-on-p planar structures created by RIE induced type conversion in MCT, as well as cross-sectional EBIC imaging undertaken at cryogenic temperatures.

Poster session / 655

Atomically Thin Indium Oxide Based Nanosheets for Optoelectronics

Author: Chung Kim Nguyen[1]

Co-authors: Nitu Syed [2]; Torben Daeneke [1]

[1] *RMIT University*

[2] *The University of Melbourne*

2D antimony doped indium oxide (IAO) nanosheets with few atom thicknesses have been synthesized utilizing liquid metal printing technique. The work proposes a viable pathway for realizing ultrathin transparent semiconducting oxides (TSOs) with enhanced electronic and optical properties.

Australian and New Zealand Conference on Optics and Photonics / 656

Superfluid Optomechanical Dissipative Solitons

Author: Walter Wasserman[None]

Co-authors: Christopher Baker [1]; Raymond Harrison [1]; Glen Harris [2]; Igor Marinkovic [1]; Andreas Sawadsky Sawadsky ; Matt Reeves [2]; Seunghwi Kim [3]; Andrea Alù [3]; Warwick Bowen [1]

[1] *The University of Queensland*

[2] *University of Queensland*

[3] *City University of New York*

Experimental results of high amplitude superfluid helium-4 waves and nonlinear phenomena including cnoidal waves, pulse trains and superfluid optomechanical dissipative solitons are presented, agreeing with the recently observed optomechanical dissipative solitons in solid state.

Conference on Optoelectronic and Microelectronic Materials and Devices / 657

Fabrication challenges towards realization of MEMS-enabled spectrally tunable metasurface filter for long-wavelength infrared

Authors: Dhirendra Kumar Tripathi[1]; Fedor Kovalev[None]; Hemendra Kala[1]; Ilya Shadrivov[2]; Lorenzo Faraone[1]; Mariusz Martyniuk[None]; Michal Zawierta[None]; Mingkai Liu[3]; Oleg Bannik[1]

[1] *The University of Western Australia*

[2] *Australian National University*

[3] *The Australian National University*

We discuss fabrication challenges to realize plasmonic MEMS-enabled tunable LWIR filter consisting of a suspended perforated gold membrane with a vertically actuated thin silicon structure above it.

Poster session / 658

Distance calibration via Newton's rings in yttrium lithium fluoride whispering gallery mode resonators

Author: Joshua Christensen[1]

Co-authors: Dmitry Strekalov ; Farhan Azeem [2]; Harald Schwefel [2]; Luke Trainor [2]

[1] *University of Otago*

[2] *Department of Physics, University of Otago, Dunedin, New Zealand.*

A high Q-factor whispering-gallery mode resonator was fabricated of yttrium lithium fluoride, furthermore an independent measurement of the coupler separation distance was explored for beam alignment and in probing the evanescent field between our couplers.

Australian and New Zealand Conference on Optics and Photonics / 660

Optomechanics with Mie-resonant dielectric particles

Authors: Ivan Toftul[1]; Yuri Kivshar[1]

[1] *Australian National University*

We analyze optical force and torque on a dielectric cylinder in the field of an evanescent field which has linear momentum, gradients, non-zero spin density. Opmochanical response have resonant nature. Torque resonances strongly depend on the azimuthal number m.

Poster session / 661

Compilation of algorithm specific graph states for quantum circuits

Author: Madhav Krishnan Vijayan[1]

Co-authors: Alexandru Paler [2]; Casey Myers [3]; Jason Gavriel [1]; Peter Rohde [1]; Simon Devitt [4]

[1] *University of Technology Sydney*

[2] *Aalto University*

[3] *Silicon Quantum Computing*

[4] *UTS*

Measurement based quantum computing is an alternate formulation of quantum computing to the ubiquitous circuit model. Here we demonstrate how to generate algorithm specific graph states to implement arbitrary quantum circuits in this model.

AIP: Quantum Science and Technology / 662

Electronic Transport in Atomically Abrupt Semiconductor Tunnel Junctions

Authors: Matthew Donnelly[None]; Mushita Masud Munia[1]; Joris Keizer[None]; Yousun Chung[None]; A.M. Saffat-Ee Huq[None]; Yuling Hsueh[None]; Rajib Rahman[2]; Michelle Simmons[2]

[1] *University of New South Wales*

[2] *The University of New South Wales*

In this work we show the results of an atomistic tight-binding approach coupled with the Non-Equilibrium Green's Function (NEGF) formalism when applied to phosphorus doped silicon tunnel junctions that can be manufactured with sub-nanometre accuracy.

AIP: Quantum Science and Technology / 663

Microwave mode cooling with room temperature diamonds

Author: Tom Day[1]

Co-authors: Abe Hiroshi [2]; Arne Laucht [1]; Brett Johnson [3]; Dane McCamey [4]; Jarryd Pla [1]; Maya Isarov [1]; Takeshi Oshima [2]; William Pappas [4]

[1] *School of Electrical Engineering and Telecommunications, UNSW Sydney, Australia*

[2] *National Institutes for Quantum Science and Technology, Japan*

[3] *Centre of Excellence for Quantum Computation and Communication Technology, School of Engineering, RMIT University, Australia*

[4] *ARC Centre of Excellence in Exciton Science, School of Physics, UNSW Sydney, Australia*

The presented work demonstrates the cooling of an X-band microwave mode with an ensemble of hyper-polarised room temperature nitrogen vacancy centres in diamond.

Poster session / **664**

Coupling Nitrogen-Vacancy Centres in Diamond to a Grape Dimer Cavity

Author: Ali Fawaz[1]

[1] *Macquarie University*

We investigate the coupling of microwave cavity fields to an ensemble of Nitrogen-Vacancy (NV) centre spins utilising the morphological resonances in spherical/ellipsoidal dielectric resonators.

AIP: Condensed Matter, Materials and Surface Physics / **665**

Time evolution of spatial coherence in exciton-polariton condensates

Authors: Bianca Rae Fabricante[None]; Thomas Donda[1]

Co-authors: Andrew Truscott ; Elena Ostrovskaya ; Eliezer Estrecho

[1] *student*

We present time-resolved measurements of the ultrafast evolution of long-range spatial coherence of trapped microcavity exciton-polariton condensates spatially separated from the reservoir.

AIP: Quantum Science and Technology / **666**

Macroscopic realism versus quantum mechanics: Macroscopic Bellinequality violations and Wheeler's delayed choice using cat states

Author: Manushan Thenabadu[1]

Co-author: Margaret Reid [1]

[1] *Swinburne University of Technology*

We predict violations of Bell, Leggett-Garg, and dimension-witness inequalities for macroscopic qubits based on macroscopically-distinct coherent states. This challenges our understanding of macroscopic realism versus quantum mechanics and motivates the examination of realism in quantum mechanics.

AIP: Theoretical and Mathematical / **667**

Entropy, and topological phase analysis in quantum simulations of the early universe with finite temperature effects

Author: Peter Drummond[1]

Co-authors: Bogdan Opanchuk [2]; King Lun Ng [2]; Manushan Thenabadu [2]; Margaret Reid [2]

[1] *Swiburne University of technology*

[2] *Swinburne University of Technology*

We present a numerical model of an early universe analog using a Bose-Einstein condensate, including temperature effects and topological properties. This may provide an insight into the particle-antiparticle asymmetry seen in our universe.

Australian and New Zealand Conference on Optics and Photonics / 668

Annealing effects in femtosecond laser-inscribed mid-infrared fibre Bragg gratings

Author: Alex Fuerbach[1]

Co-authors: Benjamin Johnston [1]; Luyi XU [1]; Michael Withford [1]; Simon Gross [1]; Toney T Fernandez [1]

[1] *Macquarie University*

Annealing effects in femtosecond laser-inscribed mid-infrared compatible fibre Bragg gratings (FBGs) are investigated via micro-reflectivity measurements. A process window for the fabrication of FBGs with improved thermal stability is identified.

AIP: Quantum Science and Technology / 669

Diamond-based quantum sensors for in situ monitoring of spin active chemical species in molecular structures and single particles

Authors: Andrei Khlobystov[1]; Bradley Flinn[1]; Melissa Mather[1]; Valentin Radu[1]

[1] *University of Nottingham*

Nitrogen Vacancies in diamond nanoparticles are employed for in situ monitoring of the magnetic state of photomagnetic materials down to the single particle level, the stability of molecular cages containing atomic Nitrogen, and spin active products of photocatalysis.

Poster session / 670

Estimation of quantum state and parameters given past and future information

Author: Qi Yu[None]

Co-author: Daoyi Dong [1]

[1] *School of Engineering and Information Technology, University of New South Wales, Canberra, ACT*

Our work considers the problem of dual quantum state-parameter smoothing, while the probability density distribution of the unknown parameters can be either static or dynamical. Based on Bayes' theorem, general formulas for dual quantum filtering and smoothing are given.

Precision and Quantum Sensing Workshop / 671

The magic of three levels: Robust quantum magnetometry at ultra low frequencies

Authors: Alex Tritt[1]; Christopher Bounds[2]; Hamish Taylor[2]; Lincoln Turner[2]; Samuel White[None]

[1] *Monash University*

[2] *School of Physics & Astronomy, Monash University, Victoria 3800, Australia.*

A discussion on utilising a dressed three level system as a magnetometer at ultra low frequencies, in the presence of dominating line noise.

Poster session / 672

Fully Stripped Beryllium-Ion Collisions with Atomic Hydrogen Initially in an Excited State

Author: Nicholas Antonio[None]

Co-authors: Alisher Kadyrov [1]; Corey Plowman ; Igor Bray [1]; Ilkhom Abdurakhmanov [2]

[1] *Curtin University*

[2] *Pawsey Supercomputing Centre*

The ITER and JET fusion reactors use beryllium-containing materials in plasma facing wall components. We calculate integrated total and state-selective electron-capture cross sections for Be^{4+} collisions with excited states of atomic hydrogen using the wave-packet convergent close-coupling method.

AIP: Biomedical and Medical Physics / 673

ABCDE: Assessing Blood vessels for Cardiovascular Disorders through the Eye

Author: Hadi Afsharan[None]

Co-authors: Barry Cense [1]; Dilusha Silva [1]

[1] *The university of Western Australia*

This work presents a trans-ocular measurement of retinal blood-vessel-wall integrity as a quantitative assessment of hypertension.

Australian and New Zealand Conference on Optics and Photonics / 674

On-The-Fly Calculation of Holographic Masks to Generate Arbitrary Spatiotemporal Beams

Author: Andrew Komonen[None]

Co-authors: Martin Ploschner [1]; Marcos Maestre Morote ; Daniel Dahl [2]; Nicolas Fontaine [3]; Joel Carpenter [2]; Mickael Mounaix [2]

[1] *School of ITEE, The University of Queensland*

[2] *The University of Queensland*

[3] *Nokia Bell Labs*

This paper presents on-the-fly calculation of holographic masks to generate arbitrary spatiotemporal beams. This includes compensating for beam defocusing through the system, allowing for advanced spatiotemporal beams to be generated at large time delays.

Australian and New Zealand Conference on Optics and Photonics / 675

Towards a sub-attometer fibre wavemeter based on Speckle interference patterns

Author: Chris Perrella[1]

Co-authors: Erik Schartner [1]; Sarah Scholten [1]; Morgan Facchin [2]; Graham Bruce [2]; Andre Luiten [1]; Kishan Dholakia [1]

[1] *University of Adelaide*

[2] *University of St Andrews*

The measurement of optical wavelengths using speckle is a promising tool for compact and precise wavemeters/spectrometers. We explore the limits of a speckle pattern-based wavemeter, aiming to achieve a measurement precision better than an attometer.

Poster session / 676

A Compact Raman System for the identification of Whisky

Author: Kwang Jun Lee[None]

Co-author: Erik Schartner

We designed and deployed a novel compact Raman spectrometer to discriminate between original and imitation whisky, with ethanol concentrations measured to within 2% accuracy. This work has application potential in the liquor industry.

Australian and New Zealand Conference on Optics and Photonics / 677

Generation of quantum entangled photons from lithium niobate nonlocal metasurfaces

Authors: Jinyong Ma[1]; Jihua Zhang[None]; Matthew Parry[None]; Marcus Cai[None]; Rocio Camacho Morales[2]; Lei Xu[3]; Dragomir Neshev[4]; Andrey Sukhorukov[None]

[1] *Research School of Physics, The~Australian National University, Canberra, ACT 2601, Australia*

[2] *The Australian National University*

[3] *Advanced Optics and Photonics Laboratory, Department of Engineering, School of Science and Technology, Nottingham Trent University, Nottingham NG11 8NS, United Kingdom*

[4] *Australian National University*

We report the first experimental generation of spatially entangled photon pairs from a metasurface incorporating a lithium niobate nonlinear thin film and the preparation of polarisation entangled states with a metasurface integrating two crossed metagratings.

Poster session / **680**

Engineered entropic forces allow ultrastrong dynamical backaction

Author: Christopher Baker[1]

Co-authors: Andreas Sawadsky [1]; Raymond Harrison [1]; Glen Harris [2]; Walter Wasserman [1]; Yasmine Sfendla [1]; Warwick Bowen [1]

[1] *The University of Queensland*

[2] *University of Queensland*

Using a superfluid helium third-sound resonator, we engineer the dynamical backaction from entropic forces, applying it to achieve optomechanical phonon lasing with a threshold power of only 2 picowatts, a factor of 2000 lower than has been shown before.

Poster session / **681**

Photonic radio frequency low pass filter based on lithium niobate on insulator recirculating modulator

Authors: Sim Tan[1]; Haijin Huang[1]; Armandas Balčytis[1]; Aditya Dubey[1]; Andreas Boes[2]; Thach Nguyen[1]; Guanghui Ren[1]; Arnan Mitchell[1]

[1] *RMIT University*

[2] *University of Adelaide; RMIT University*

we demonstrate the electro optic comb from the recirculating modulator can be used for high performance lowpass filter without reshaping the comb, which provide the potential integration of the on-chip signal processor. We also demonstrate high-speed image and video processing.

Poster session / **682**

A survey of methods for predicting electronic structure

Author: Tanglaw Roman[None]

Co-authors: Darryl Jones [1]; Reece Waltrovitz [2]; Benjamin Chambers [1]; Sarah Harmer [2]

[1] *College of Science and Engineering, Flinders University*

[2] *Flinders University*

We carry out a comprehensive survey of ab initio methods to predict the electronic band structure of Ag, graphene, and FeSe, and compare the results with ARPES data.

AIP: Quantum Science and Technology / 683

Optimising Cryogenic Wiring for Superconducting Qubit Processors in a Dilution Refrigerator

Authors: Adrien Di Lonardo[1]; Nathan Langford[1]

Co-author: Juan Pablo Dehollain [1]

[1] *University of Technology Sydney*

As quantum processors begin to scale, optimising the cryogenic wiring for superconducting quantum devices is becoming an important challenge for developing powerful quantum computers. This work tackles this problem for industry-scale devices and identifies new avenues for improving qubit capacities.

AIP: Quantum Science and Technology / 684

Quantum sensing with diamond spin maser at room-temperature

Author: Sarath Raman Nair[1]

Co-authors: Ali Fawaz [1]; Lyra Cronin [1]; Thomas Volz [1]

[1] *ARC Centre of Excellence for Engineered Quantum Systems and School of Mathematical and Physical Sciences, Macquarie University, Australia*

We present the theoretical study of diamond spin maser magnetic field sensor's limitations considering a detailed photo-physics of the spins. We also present our progress towards the experimental realization of such a sensor.

AIP: Quantum Science and Technology / 685

Quantum Control of Ensemble Nitrogen-Vacancy Spins in Diamond with Spin Bath Driving

Author: Jemy Geordy[1]

Co-authors: Alexander Hahn [1]; Daniel Burgarth [1]; Kazuya Yuasa [2]; Sarath Raman Nair [1]; Thomas Volz [1]

[1] *School of Mathematical and Physical Sciences, Macquarie University, Australia and ARC Centre of Excellence for Engineered Quantum Systems, Macquarie University, Australia*

[2] *Department of Physics, Waseda University, Tokyo, Japan*

Nitrogen-Vacancy centres in diamond are promising room-temperature quantum sensors. However, interaction with bath-spins in the surrounding lattice can lead to strong decoherence. We investigate decoupling of these interactions by driving the bath-spins with chirped signals.

Poster session / **686**

Novel Ultrafast Laser Inscribed Multi-Pass Waveguides for Reduced Bend Losses

Author: Andrew Ross-Adams[1]

Co-authors: Michael Withford [1]; Simon Gross [1]

[1] *Macquarie University*

Demonstration of a novel multi-pass approach to ultra-fast laser inscribed waveguide fabrication, which improves optical mode confinement and reduces bend losses for small radii of curvature, enabling more compact photonic integrated circuits and greater integration density.

AIP: Theoretical and Mathematical / **687**

On two particular N-state generalizations of the quantum Ising model

Author: Murray Batchelor[1]

Co-authors: Remy Adderton ; Robert Henry

[1] *Australian National University*

In this talk I will describe recent progress on two particular N-state generalizations of the widely studied quantum Ising model – the N-state superintegrable chiral Potts model and the Z(N) free parafermion model.

AIP: Quantum Science and Technology / **688**

New Methods for Noiseless Linear Amplification and Quantum Teleportation of Multiphoton Quantum States

Author: Joshua Guanzon[1]

Co-authors: Austin Lund [1]; Matthew Winnel [1]; Timothy Ralph [1]

[1] *The University of Queensland*

We discovered a new practical method of perfectly amplifying and teleporting multiphoton light. It is shown to be better than established alternatives. This type of amplifier is useful for a huge variety of quantum technologies.

Poster session / **689**

On-chip high speed photodetectors for microwave photonic filters

Author: Paramjeet Kaur[1]

[1] *Research Scholar*

In this contribution, we report on the progress of integrating high-speed detectors on PIC for achieving single-chip microwave photonic filters.

Australian and New Zealand Conference on Optics and Photonics / 690

Terahertz Vector Beam Generation Enabled by Photonic Topological Metasurfaces

Author: Elizaveta Melik-Gaykazyan[1]

[1] *Australian National University*

We propose and numerically investigate the mechanism of vector beams formation in terahertz spectral range via engineering the band structure of spatially inhomogeneous photonic metasurfaces supporting topologically trivial and non-trivial states.

Poster session / 691

A quantum model of a time-travelling billiard ball

Author: Lachlan Bishop[None]

Co-authors: Fabio Costa ; Timothy Ralph

Indeterministic dynamics arise in the context of interacting systems near closed timelike curves. I will discuss a relevant scenario, the “billiard-ball paradox”, and will provide solutions to a quantum formulation of the problem, showing in particular how indeterminism is resolved.

Poster session / 692

Evaluating the Effectiveness of Virtual Reality in Secondary School Physics Outreach

Author: Madeline Parks[None]

Co-authors: Daniel Brown [1]; Edward Palmer [1]

[1] *The University of Adelaide*

Can Virtual Reality make it easier to communicate Physics to young people? We evaluated *Mission Gravity*, an OzGrav outreach program delivered in Virtual Reality, and assessed its impact in South Australian Secondary School classrooms.

7th International Workshop on Speciality Optical Fibres / 693

Silica Optical Fibres via 3D Printing Technologies

Author: Gang-Ding Peng[None]

We report recent progresses and discuss key technical challenges in research and development of specialty silica optical fibres via 3D printing technologies.

AIP: Atomic and Molecular Physics / 694

Simultaneous Reconstruction and Structural Fitting of the Complex Atomic Fine Structure of Copper and Iron

Author: Paul Di Pasquale[1]

Co-authors: Chanh Tran [1]; Christopher Chantler [2]; Zwi Barnea [2]; Tony Kirk [1]; Minh Dao [1]; Eugeniu Balaur [1]; Grant van Riessen [1]; Gerard Hinsley [1]; Anirudh Jallandhra [3]; Julian Ceddia [4]; Jake Rogers [1]; Cameron Kewish [5]; David Paterson [5]; Juliane Reinhardt [5]; Nigel Kirby [5]; Stephen Mudie [5]

[1] *La Trobe University*

[2] *University of Melbourne*

[3] *RMIT*

[4] *Monash University*

[5] *ANSTO*

A novel technique for determining complex atomic fine structure will be described. Exciting applications of the technique such as a phase analogue to x-ray absorption fine structure applications will also be discussed.

Australian and New Zealand Conference on Optics and Photonics / 695

Asymmetric and nonreciprocal control of light with dielectric metasurfaces

Author: Sergey Kruk[1]

[1] *Australian National University*

Experimental results on nonreciprocal one-way transmission of light (optical isolation) through ultra-thin dielectric metasurfaces will be reported. Experimental observations of asymmetric parametric generation of images with nonlinear dielectric metasurfaces will be presented.

AIP: Quantum Science and Technology / 696

Fundamental limits of quantum error mitigation

Author: Ryuji Takagi[1]

Co-authors: Mile Gu [1]; Shintaro Minagawa [2]; Suguru Endo [3]

[1] *Nanyang Technological University*

[2] *Nagoya University*

[3] *NTT Corporation*

We establish universal performance bounds pertaining to the general quantum error mitigation protocols. We employ them to show the fundamental difficulty of mitigating noise in variational quantum circuits and the optimality of the probabilistic error cancellation method.

Poster session / **697**

Towards long-wave infrared narrowband tunable FPIs

Author: Gurpreet Singh Gill[1]

Co-authors: Michal Zawierta ; Dhirendra Kumar Tripathi [2]; Adrian Keating ; Gino Putrino ; Dilusha Silva [2]; Lorenzo Faraone [2]; Mariusz Martyniuk

[1] *University of Western Australia*

[2] *The University of Western Australia*

This work presents a surface micromachined long-wave infrared tunable Fabry–Pérot interferometer (FPI) incorporating Ge/BaF2/Ge solid-material distributed Bragg's reflectors (DBRs) for 8–10 μm optical wavelength range. This work also represents a reliable and reproducible fabrication process for tunable cavity LWIR FPIs.

Poster session / **698**

The shareability of steering in two-producible states

Author: Qiucheng Song[None]

Co-authors: Howard Wiseman [1]; Travis Baker [1]

[1] *Griffith University*

We study steerabilities of various n-party 2-producible entangled states. Most strikingly, a state produced from a single 2-qubit state allows one party shared a qubit from entangled state to steer any one of the n-1 otherparties for arbitrarily large n.

AIP: Nuclear and Particle Physics / **699**

Challenging nuclear vibrations with particle-gamma spectroscopy

Author: Martha Reece[None]

Co-authors: AJ Mitchell [1]; Benjamin John Coombes [2]; Gregory Lane [1]; Hanaa Alshammari [1]; Victoria Bashu [1]; Matthew Gerathy ; Peter Charles Mcnamara ; Lachlan McKie [1]; Andrew Stuchbery [3]

[1] *Australian National University*

[2] *Australian National University (AU)*

[3] *The Australian National University*

This presentation will discuss preliminary attempts to perform Coulomb excitation of ^{124}Te with the CAESAR array at the ANU as part of a larger investigation into the vibrational nature of near-spherical nuclei.

AIP: Quantum Science and Technology / 700

Signatures of critical dynamics in quantum phase transitions observed through digital quantum simulations

Author: Juan Pablo Dehollain[1]

[1] *University of Technology Sydney*

We present techniques, compatible with measurements in digital quantum simulations, for studying critical dynamics in quantum phase transitions, based on the Kibble-Zurek mechanism. In particular, we introduce a sample-and-hold protocol that enables the study of critical exponents in the system.

AIP: Education / 701

Playing Music with Molecules: a Spectroscopic Symphony for Scientific Education and Engagement

Authors: David Simpson[None]; Di Wang[1]; Ella Walsh[2]; Erin Grant[2]; Jake Willett[1]; Joshua Ezackial[1]; Liam Hall[3]; Sepehr Ahmadi[4]

[1] *University of Melbourne*

[2] *The University of Melbourne*

[3] *School of Chemistry, the University of Melbourne*

[4] *CSIRO*

We detail a new, more inclusive approach to teaching quantum concepts to both students and non-scientific audiences; based on direct real-time interactions between musical instruments with quantum systems at audio frequencies.

AIP: Nuclear and Particle Physics / 702

Defining and identifying pre-collective nuclei through electromagnetic transitions and moments

Author: Ben Coombes[None]

Co-authors: AJ Mitchell ; Andrew Stuchbery [1]; Brian Tee [1]; Georgi Georgiev ; Gregory Lane [2]; Jackson Dowie [1]; James Allmond [3]; Matthew Gerathy ; Nathan Spinks ; Tibor Kibédi [4]; Timothy Gray [1]

[1] *ANU*

[2] *Australian National University*

[3] *ORNL*

[4] *The Australian National University*

The nature of pre-collective nuclei is discussed in relation to recent measurements of M1 and E2 observables in the Te isotopes. Common features of pre-collective nuclei are investigated with the intention of understanding the onset of nuclear collectivity.

Poster session / **703**

Solid-immersion lenses integrated into a tunable fiber cavity for enhancing polariton-polariton interactions

Author: Raji Bhaskaran Nair[1]

Co-authors: Sarath Raman Nair ; Lorenzo Scarpelli ; Sylvain Ravets ; Martina Morassi ; Aristide Lamaitre ; Jacqueline Bloch ; Maxime Richard ; Thomas Volz

[1] *Macquarie University*

we integrate solid immersion micro-lenses into a fibre-based microcavity-polaritons system to increase photonic confinement and achieving stronger optical nonlinearities.

Poster session / **704**

High-precision laser Doppler velocimetry off an airborne target

Authors: David Gozzard[1]; Skevos Karpathakis[1]; Shane Walsh[2]; Ayden McCann[1]; Alex Frost[1]; Charles Gravestock[1]; Sascha Schediwy[1]; Benjamin Dix-Matthews[1]

[1] *The University of Western Australia*

[2] *University of Western Australia*

We demonstrate laser Doppler velocimetry to a moving airborne drone at a distance of 600 m, achieving an in-line velocity precision of 2 nm/s with 10 seconds of averaging.

Poster session / **705**

Precision Optical Metrology of ATLAS ITk Strip Modules for the HL-LHC upgrade

Author: Tony Tran[1]

Co-authors: Geoffrey Taylor [2]; James Webb [2]; Scott David Williams [1]

[1] *University of Melbourne (AU)*

[2] *University of Melbourne*

To ensure each detector module comprising the upgraded ATLAS ITK detector is produced at a high standard, detector modules undergo rigorous Quality Control and Quality Assurance. This work presents the optical metrology surveys and results.

Poster session / **706**

Vaidya to Rindler transformation and the Hawking radiation

Author: Pravin Kumar Dahal[1]

[1] *Macquarie University*

We perform coordinate transformations on the Vaidya metric in advanced coordinate to reduce it into the Rindler metric near the horizon. We then apply the periodicity time trick to extract Hawking temperature.

AIP: Quantum Science and Technology / **707**

Testing Generalised Uncertainty Principles through Quantum Noise and Trajectories

Author: Parth Girdhar[1]

Co-author: Andrew Doherty [2]

[1] *UNSW*

[2] *University of Sydney*

We explore how generalisations of the Heisenberg principle arising from modified canonical commutation relations can produce significant effects in recent observations of optomechanical backaction noise, as well as in quantum trajectories of moments derived from general continuous position measurements.

AIP: Group for Astroparticle Physics / Astronomy / **708**

Supermassive black holes from supermassive stars

Author: Alexander Heger[1]

[1] *Monash University*

The formation of supermassive black holes that power high-redshift quasars poses a challenge to our understanding of era of first stars and first galaxies. We present models of supermassive stars and their fates.

Poster session / **709**

Current Status and the Future for Automation and Monitoring of Calibration Procedures at the Belle II Experiment

Author: David Dossett[None]

Co-authors: Francis Pham ; Martin Sevior [1]

[1] *The University of Melbourne*

Some new developments and lessons learned in the automated calibration system for the Belle II experiment over the past two years.

AIP: Nuclear and Particle Physics / 710

Direct measurement of hexacontatetrapole, E6 γ decay from Fe-53m

Author: AJ Mitchell[None]

Co-authors: Alex Brown [1]; Andrew Stuchbery [2]; Aqeel Akber [3]; Ben Coombes ; Gregory Lane [3]; Jackson Dowie [3]; Matthew Gerathy ; Matthew Reed [3]; Mitchell de Vries [4]; Thomas Palazzo [3]; Tibor Kibédi [2]

[1] *Michigan State University*

[2] *The Australian National University*

[3] *Australian National University*

[4] *RMIT University*

This presentation describes an experimental study of the highest-multipole transition known in nature—the proposed E6 γ-decay of ^{53m}Fe— and attempts to understand this rare process through Shell Model calculations performed in the full fp-shell model space.

AIP: Atomic and Molecular Physics / 711

Radiokrypton Dating using Atom Trap Trace Analysis

Author: Thomas Chambers[1]

Co-authors: Alec Deslandes [2]; Andre Luiten [3]; Axel Suckow [2]; Christoph Gerber [2]; Dirk Mallants [2]; Phillip Light [4]; Rohan Glover [1]

[1] *University of Adelaide*

[2] *CSIRO*

[3] *The University of Adelaide, QuantX Labs*

[4] *The University of Adelaide*

Radioactive Noble Gas isotopes are ideal tracers of environmental processes. Due to their low abundances, a lack of measurements is a limitation in climate modelling. We present progress towards an Atom Trap Trace Analysis (ATTA) facility for overcoming this limitation.

AIP: Nuclear and Particle Physics / 712

Graph Neural Networks for studying processes involving top quarks at colliders

Author: Thomas Nommensen[1]

Co-authors: Anthony Little [2]; Kevin Varvell [2]

[1] *The University of Sydney*

[2] *University of Sydney (AU)*

Graph Neural Networks (GNNs) are increasingly being deployed when analysing data from particle physics experiments. We will present preliminary studies involving the application of GNNs to the problem of identifying processes involving top quarks in a collider environment.

7th International Workshop on Speciality Optical Fibres / **713**

Exploiting complex light transmission in multimode optical fibre for distributed sensing

Author: Darcy Smith[1]

Co-authors: David Ottaway [2]; Linh Viet Nguyen [3]; Mohammad Istiaque Reja [4]; Stephen Warren-Smith

[1] *Future Industries Institute, University of South Australia*

[2] *University of Adelaide*

[3] *University of South Australia*

[4] *Institute for Photonics and Advanced Sensing, School of Physical Sciences, The University of Adelaide, Adelaide, SA 5005, Australia*

We exploit the complex nature of light transmission through multimode fibre for distributed fibre temperature sensing. This is achieved by training a regression deep neural network for extracting distributed temperature information from fibre wavelength spectra.

Poster session / **714**

Laser Threshold Magnetometry with Diamond Ring Resonator

Author: Christopher Kortholt[1]

Co-authors: Andrew Greentree [1]; Christian Giese [2]; Jan Jeske [2]; Qiang Sun

[1] *RMIT University*

[2] *Fraunhofer IAF*

Here we model a Laser threshold magnetometer sensor with extremely high sensitivity. We predict the sensitivities of a sensor design utilising a diamond ring resonator as a function of resonator geometry and optical pump conditions.

AIP: Quantum Science and Technology / **715**

Coherent magnetic and electric control of a single spin-7/2 donor atom in silicon

Author: Arjen Vaartjes[1]

Co-authors: Alexander Jakob [2]; Andrea Morello [3]; Andrew Dzurak [4]; Benjamin Joecker [4]; Daniel Schwienbacher [4]; David Jamieson [2]; Fay Hudson [4]; Irene Fernandez de Fuentes [4]; Tim Botzem [4]

[1] *PhD student*

[2] *University of Melbourne*

[3] *UNSW, Sydney*

[4] *UNSW*

High spin donor atoms are objects of interest in semiconductor quantum architectures due to their large Hilbert space dimensionality. Here we demonstrate high fidelity coherent control over the 16-dimensional Hilbert space of a single 123-Sb atom implanted in silicon.

AIP: Quantum Science and Technology / 717

Enhanced accuracy in dimensionally-constrained quantum models

Authors: Andrew Garner[1]; Chengran Yang[2]; Feiyang Liu[3]; Jayne Thompson[None]; Nora Tichler[4]; Yung Man-Hong[3]; Oscar Dahlsten[5]

[1] *Institute for Quantum Optics and Quantum Information, Austrian Academy of Sciences*

[2] *Nanyang Technological University*

[3] *Southern University of Science and Technology*

[4] *Griffith University*

[5] *Southern University of Science and Technology,*

See Abstract Attached

Poster session / 718

Simulating power cable damage through monitoring temperature of multimode optical fibres with a state-of-the-art distributed sensing instument

Authors: Andreas Ioannou[1]; Charalampos Kouzouopou[1]

Co-authors: Adam Landos [1]; Andreas Metaxas [1]; Antreas Dionysiou [2]; Avi Zadok [3]; Efstathios Stavrakis [4]; Kyriacos Kalli [1]; Maria Argyrou [1]; Michalis Agathocleous [2]; Nicolas Nicolaou [4]; Sotirios Chatzis [1]

[1] *Cyprus University of Technology*

[2] *Resoloupe LTD*

[3] *Bar Ilan University*

[4] *Algolysis LTD*

Detection of simulated failures in underground power cables using Multimode fibers. Failure in underground power cable couases overheat (hot-spot), and locating the problem is difficult. Detection is achieved through Distributed Temperature Sensors that use RAMAN-based measurements for high-precision temperature detection.

Poster session / 719

Nano/Microstructure for spectra modulation by laser fabrication

Author: JIHONG HAN[None]

Co-authors: Baohua Jia [1]; Han Lin [1]; Keng-Te Lin [1]

[1] *RMIT*

Nano/Microstructure for spectra modulation by laser fabrication

7th International Workshop on Speciality Optical Fibres / 720

Design of scintillator-based dosimeters using femtosecond laser processed polymer optical fibers for radiation measurement

Author: Andreas Ioannou[1]

Co-authors: Andreas Pospori [1]; Aristi Christofi [1]; David A. Jackson [2]; Francis J. Sullivan [3]; Kyriacos Kalli [1]; Peter Woulfe [4]; Sinead O'Keeffe [5]; Sotia Zarvou [1]; Wern Kam [5]

[1] *Cyprus University of Technology*

[2] *University of Kent*

[3] *National University of Ireland*

[4] *Galway Clinic*

[5] *University of Limerick*

We present simple and robust designs for optical fiber radiation sensors for dosimetry applications, by utilizing femtosecond laser micromachining.Furthermore, we examine the implementation of our technique with plastic scintillator (BCF-10) for medical radiotherapy dosimetry.

Conference on Optoelectronic and Microelectronic Materials and Devices / 721

Polarimetric Imaging Photodetector based on Sb2Se3 Nanowires

Authors: Huijia Luo[1]; Songqing Zhang[1]

Co-authors: Han Wang [1]; Lorenzo Faraone [1]; Wen Lei [1]

[1] *Department of Electrical, Electronic and Computer Engineering, The University of Western Australia, Perth 6009, Australia*

This work presents a study on the chemical vapor deposition-grown Sb2Se3 nanowires and their applications in polarized photodetection. The fabricated photodetector exhibits a good sensitivity to polarized light at 830nm. Conventional and polarimetric imaging are also achieved under white light.

Conference on Optoelectronic and Microelectronic Materials and Devices / 722

Fabrication of MEMS Silicon Nitride Photonic Switch

Author: Shubhashree Swain[1]

[1] *PhD Candidate, The University of Western Australia*

In this paper, we present the proof of concept of a fast silicon nitride photonic switch with MEMS actuation by using conventional lithography. Fabrication and optical characterisation of the device have been demonstrated successfully.

AIP: Quantum Science and Technology / 723

Tunable “adiabatic” qubit-cavity gates for digital quantum simulations in circuit QED

Author: Angsar Manatuly[None]

In this work, we introduce new “adiabatic” techniques for implementing Jaynes-Cummings qubit-cavity interactions that enable low-bandwidth, ultrashort effective Jaynes-Cummings pulses. We demonstrate tunable positive- and negative-time Jaynes-Cummings gates with >99% fidelity for up to 100 sequential gates.

AIP: Quantum Science and Technology / 724

Quantum Chaos and Universal Trotterisation Behaviours in Quantum Simulations

Author: Cahit Kargi[1]

Co-authors: Fabio Henriques [1]; Juan Pablo Dehollain [1]; Lukas M Sieberer [2]; Markus Heyl [3]; Nathan K Langford [1]; Peter Zoller [2]; Philipp Hauke [4]; Tobias Olsacher [2]

[1] *University of Technology Sydney*

[2] *University of Innsbruck*

[3] *University of Augsburg*

[4] *University of Trento*

In this talk, we present universal performance behaviours in Trotterised digital quantum simulations. For example, beyond a threshold in Trotter step size, the Trotterisation performance breakdown with the onset of quantum chaos, meaning the Trotterised unitary becomes a random matrix.

Poster session / 726

QuanGuru: A Python Package for Numerical Modelling of Quantum Systems

Author: Cahit Kargi[1]

Co-authors: Adrien Di Lonardo [1]; Angsar Manatuly ; Fabio Henriques [1]; Giorge Gemisis [1]; Juan Pablo Dehollain [1]; Nathan K Langford [1]

[1] *University of Technology Sydney*

In this talk, we introduce a new Python library, named QuanGuru, that implements powerful abstractions providing a broad range of useful and highly versatile functionalities, and show QuanGuru examples.

7th International Workshop on Speciality Optical Fibres / 728

Metal-coated optical fiber embedment in WAAM aluminium parts for distributed temperature sensing

Author: Krzysztof Wilczyński[1]

[1] *InPhoTech sp. z o.o., ul. Poznanska 400, 05-850 Oltarzew, Poland*

Metal–coated optical fibers are known for its resistance to extreme temperatures and superior mechanical properties. This research is focused on evaluating use of such technology within smart materials (3D metal printing) for temperature measurements.

Poster session / **729**

Technology evaluation of low loss all-fiber fanouts for multicore fibers

Author: Krzysztof Wilczyński[1]

[1] *InPhoTech sp. z o.o., ul. Poznanska 400, 05-850 Oltarzew, Poland*

In this work we present our all-fiber fanout technology and the results of its evaluation. The broadband, low-loss components were tested for optical, environmental and mechanical performance showing high maturity and readiness for field deployments.

7th International Workshop on Speciality Optical Fibres / **730**

Selectively tuning the temperature and humidity sensitivity of CYTOP fibre Bragg grating sensors

Author: Andreas Ioannou[1]

Co-authors: Andreas Pospori [1]; Kyriacos Kalli [1]

[1] *Cyprus University of Technology*

The possibility of tuning the temperature and humidity sensitivities of POFBG sensors to the desired level by applying a specific amount of fibre pre-strain is demonstrated.

7th International Workshop on Speciality Optical Fibres / **731**

Tradeoff between the Brillouin and transverse mode instabilities in high-power fiber amplifiers

Author: Jonathan Hu[1]

Co-authors: Curtis Menyuk [2]; Josh Young [1]

[1] *Baylor University*

[2] *University of Maryland Baltimore County*

The transverse mode instability is a nonlinear effect that limits the power in high-energy lasers. We describe the phase-matched model for TMI which yields a drastic speedup in computation time with no loss of accuracy.

AIP: Nuclear and Particle Physics / 733

Study of Exclusive B → π ℓ ν Decays with Hadronic Full-event-interpretation Tagging in Belle II Data and Extraction of |Vub|

Author: Nadia Toutounji[1]

Co-author: Kevin Varvell [1]

[1] *University of Sydney*

A measurement of the magnitude of the Cabibbo-Kobayashi-Maskawa matrix element $|V_{\mathrm{ub}}|$ is extracted exclusively from the semileptonic B-meson decay $B \to \pi\ell\nu$ in an early subset of Belle II data using hadronic Full-event-interpretation tagging.

Conference on Optoelectronic and Microelectronic Materials and Devices / 734

Waveguide Design and Its Impact on Ultraviolet-A III-Nitride Diode Lasers

Author: Luke Mawst[1]

Co-authors: Cheng Liu [1]; Chirag Gupta [1]; Dominic Lane [2]; Guangying Wang [1]; Jesus Perez [1]; Jiahao Cheng [1]; Jing Zhang [3]; Matthew Dwyer [4]; Matthew Seitz [3]; Nelson Tansu [2]; QINCHEN LIN [1]; Shubhra Pasayat [1]; Tom Earles [4]; Yuting Li [1]

[1] *University of Wisconsin-Madison*

[2] *The University of Adelaide*

[3] *Rochester Institute of Technology*

[4] *DRS Daylight Solutions*

III-Nitride material system has been utilized to obtain high-performance UV-A lasers. In this study, we focused on understanding the impact of waveguide thickness on the performance of 390 nm GaN laser diodes.

Conference on Optoelectronic and Microelectronic Materials and Devices / 735

Selectively-Grown InGaN/GaN Quantum Dots

Author: Luke Mawst[None]

Co-authors: CHENG LIU ; Chirag Gupta ; Dominic Lane ; Jian Sun ; Miguel A. Betancourt Ponce ; Nelson Tansu ; Nikhil Pokharel [1]; Padma Gopalan ; Shubhra S. Pasayat

[1] *University of Wisconsin Madison*

We employ nanopatterning, via diblock co-polymer lithography, and selective area-MOVPE growth to achieve high-density InGaN/GaN quantum dots for UV applications

Poster session / 736

Towards Bragg-based gravimetry on compact devices: A readout delay free scheme for measuring phase shifts with spatial fringes matter-wave interferometry

Author: Yosri Ben Aicha[None]

Co-authors: John Close [1]; Rhys Eagle ; Ryan Thomas [2]; Samuel Legge [3]; Simon Haine ; Zain Mehdi [2]

[1] *Supervisor*

[2] *The Australian National University*

[3] *Australian National University*

We present a novel atom interferometry scheme that allows readout-delay-free measurement by extracting phase information from overlapped spatial fringes to measure gravity on compact devices using Bragg pulses.

Focus Session / **737**

Metasurfaces for High Numerical Aperture Optical Signal Processing

Author: Niken Priscilla[None]

Co-authors: Ann Roberts [1]; Lukas Wesemann [1]; Timothy J. Davis [1]; Wendy C. S. Lee [1]

[1] *The University of Melbourne*

Metasurfaces constructed of subwavelength periodic arrays of metal particles have been shown to possess asymmetric optical transfer function with a relatively high numerical aperture of ~0.5 enabling phase imaging of diverse transparent objects.

Conference on Optoelectronic and Microelectronic Materials and Devices / **738**

Generation of Large-Scale Entanglement on Physical Quantum Devices

Author: Gary Mooney[1]

Co-authors: Charles Hill [2]; Gregory White ; Lloyd Hollenberg

[1] *University of Melbourne*

[2] *The University of Melbourne*

We generate and verify entanglement in sizeable multiqubit states prepared on IBM Quantum superconducting devices. We report the detection of whole-device bipartite entanglement on a 65-qubit quantum device and genuine multipartite entanglement over all qubits of a 27-qubit quantum device.

Poster session / **739**

Investigation of the Extrusion Parameters for Tellurite Optical Fibres

Author: Jobaida Akhtar[1]

Co-authors: Erik Schartner [1]; Jiawen Li [2]; Heike Ebendorff-Heidepriem [1]

[1] *Institute for Photonics and Advanced Sensing, The University of Adelaide, SA 5005, Australia and School of Physical Sciences, The University of Adelaide, SA 5005, Australia.*

[2] *Institute for Photonics and Advanced Sensing, The University of Adelaide, SA 5005, Australia and cSchool of Electrical and Electronic Engineering, The University of Adelaide, SA 5005, Australia.*

We report the investigation of extrusion die and glass billet parameters on the loss of tellurite fibre. The billet surface quality was found to be critical to achieve low fibre loss.

AIP: Nuclear and Particle Physics / 742

Finite volume pionless effective field theory for nuclear systems

Authors: Phiala Shanahan[None]; William Detmold[None]

Finite-volume pionless effective field theory is an efficient framework with which to perform the extrapolation of finite-volume lattice QCD calculations of multi-nucleon spectra and matrix elements to infinite volume and to nuclei with larger atomic number. Recent progress is reviewed.

Conference on Optoelectronic and Microelectronic Materials and Devices / 743

Growth and Characterization of AlGaInN Alloys Lattice-Matched to GaN

Author: Nelson Tansu[1]

Co-authors: Hanlin Fu [2]; Justin Goodrich [3]

[1] *The University of Adelaide*

[2] *Lumileds LLC*

[3] *Brookhaven National Laboratory*

In this work, we perform epitaxial growth and characterizations of AlGaInN alloys lattice-matched to GaN with four different compositions. The understanding of growth conditions and optical properties of AlGaInN alloys are essential for integration with GaN-based applications.

Conference on Optoelectronic and Microelectronic Materials and Devices / 744

Nanoscale-Engineered InGaN/GaN Quantum Wells via Machine Learning Design

Author: Nelson Tansu[None]

Co-authors: Hanlin Fu ; Onoriode N. Ogidi-Ekoko ; WEN LIANG

We present the machine learning design of nanoscale-engineered InGaN-based QW with ten sublayers for enhanced performance based on a heuristic algorithm. Such a design approach can achieve significant improvements in the material gain characteristics and current density of QW.

Poster session / **745**

Crystallinity Properties of Ternary III-Oxide Alloys

Author: Justin Goodrich[1]

Co-authors: Hanlin Fu [2]; Nelson Tansu [3]

[1] *Brookhaven National Laboratory,*

[2] *Lumileds LLC*

[3] *The University of Adelaide*

In this work, DFT analysis is employed to study the structural evolution of ternary III-oxides, such as (InxAl1-x)2O3, (AlyGa1-y)2O3, and (GazIn1-z)2O3, determining the compositions at which phase transitions occur and important physical parameters.

AIP: Quantum Science and Technology / **746**

Vacuum Noise Squeezing with a Kinetic Inductance Parametric Amplifier

Authors: Anders Kringhoej[None]; Andrea Morello[None]; Arjen Vaartjes[None]; Jarryd Pla[None]; Nicolas Menicucci[None]; Tom Day[None]; Wyatt Vine[None]

Squeezing electromagnetic noise allows for measurements beyond the standard quantum limit relevant to a range of quantum applications. Here we present the first results in realising direct noise squeezing with a kinetic inductance parametric amplifier.

Poster session / **747**

How Wings Actually Work: Navier-Stokes and Viscosity not Coanda or Others

Author: Graham Wild[1]

[1] *UNSW*

Recently, YouTube science communicators have tried to explain lift. Unfortunately, fluids are not intuitive, and Navier-Stokes provides little qualitative insight. Saying Coanda is as incorrect as claiming equal transit, or simply saying Bernoulli. How do wings work? Navier-Stokes and viscosity!

7th International Workshop on Speciality Optical Fibres / **748**

Embedding Fibre Sensors in 3D Printed Lightweight Aircraft Structures

Author: Luke Pollock[1]

Co-authors: Alexander Somerville [1]; Graham Wild [2]

[1] *UNSW Canberra*

[2] *UNSW*

This work explores embedded fibre optic sensors in lightweight PLA during 3D printing for applications in aircraft structures. The sensors are used for strain and shape sensing of a wind tunnel model of a box-wing.

Poster session / **749**

pol-PICTS: a new method to reveal trapping dynamics and energetics of SDR-active defects

Authors: Agatha Ulibarri[None]; Brett Johnson[None]; Jeff McCallum[None]; Dan McCloskey[None]; Jean-Christophe Harmand[None]; Martina Morassi[None]; Franck Fortuna[None]; Natalia Alyabyeva[None]; Alistair Rowe[None]

SDR is an exciting pathway toward spintronic devices. This work presents the first measurements of the thermal activation energy and carrier capture cross-sections of the SDR-active Ga2+ interstitial defect using a new experimental technique: polarized photo-induced current transient spectroscopy (pol-PICTS).

Australian and New Zealand Conference on Optics and Photonics / **750**

Spin entanglement of a thermal atomic pair in an optical tweezer

Author: Lucile Sanchez[None]

Co-authors: Marvin Weyland [1]; Mikkel F. Andersen [1]; Poramaporn Ruksasakchai [1]; Scott Parkins [2]; Stuart Szigeti [3]

[1] *University of Otago, Department of Physics*

[2] *University of Auckland*

[3] *The Australian National University*

We study spin-exchange collision as a route to thermally robust entanglement of two atoms in a microtrap. For probing it, we perform a Hong-Ou-Mandel experiment in which a Raman transition pulse plays the beam splitter role and compare with simulation.

AIP: Education / **751**

Incorporating a Flight Simulator Based Laboratory for Physics of Motion

Authors: Alexander Somerville[1]; Graham Wild[2]

Co-author: Luke Pollock [1]

[1] *UNSW Canberra*

[2] *UNSW*

Traditional physics of motion laboratories involve air tracks/tables. Activities should facilitate understanding of concepts and represent real-world/authentic activities for engagement. Using a physics-based flight-simulator, X-Plane11, students perceived positive learning outcomes with an authentic engaging activity, with a real-world application.

AIP: Nuclear and Particle Physics / 752

SUPL – An underground laboratory for fundamental science in Australia

Author: Geoffrey Norman Taylor[1]

[1] *University of Melbourne (AU)*

Describes the new underground fundamental science facility, SUPL, driven by the particle and nuclear physics, and astrophysics communities.
outline of facility came, it characteristics and status of installation DM search experiment SABRE. Other potential activities for SUPL described.

AIP: Quantum Science and Technology / 753

Compression of QFT States Using Wavelets

Author: Dan George[1]

Co-authors: Yuval Sanders [2]; Mohsen Bagherimehrab [3]; Barry Sanders [4]; Gavin Brennen [1]

[1] *Macquarie University*

[2] *University of Technology Sydney*

[3] *University of Toronto*

[4] *University of Calgary*

We apply the wavelet transform to generate compressed representations of ground states of QFTs and demonstrate applications such as identification of quantum phase transitions via fidelity overlap and approximation of the holographic entanglement of purification.

Australian and New Zealand Conference on Optics and Photonics / 754

Correlation between Crystal Size and Photo Luminescence Intensity of SiV Centres in HTHP Nanodiamonds

Author: Taras Plakhotnik[None]

We show that photo luminescence rate of silicon-vacancy centres in HTHP diamond is proportional to the sixth power of crystal diameter and consider interactions of photons with centres and kinetics of the crystals growth to explain the results.

AIP: Quantum Science and Technology / 755

Stabiliser subsystem decompositions for single- and multi-mode

Author: Andrew Doherty[1]

Co-authors: Arne Grimsmo [1]; Mackenzie Shaw [1]

[1] *The University of Sydney*

We analyse the performance of Gottesman Kitaev Preskill quantum error correcting codes during gates and under realistic noise such as loss and dephasing using a new subsystem decomposition.

AIP: Nuclear and Particle Physics / 756

Electric monopole transitions in nuclei

Author: Tibor Kibedi[1]

[1] *Australian National University*

E0 transitions are unique to nuclei and provide a compelling spectroscopic fingerprint of shape coexistence. Recent results from 12C, 24Mg and 40Ca will be used to examine nuclear structure questions where the observation and characterisation of E0 transitions were crucial.

AIP: Condensed Matter, Materials and Surface Physics / 757

Interactions Between Exciton-Polarons in Monolayer WS_2

Author: Jeffrey Davis[1]

[1] *Swinburne University of Technology*

The dominant interactions between polarons in monolayer WS_2 occur between polarons dressed by the same Fermi-sea of electrons. Repulsive interactions are mediated by phase space filling, while attractive interactions lead to the formation of bipolarons.

AIP: Condensed Matter, Materials and Surface Physics / 758

Intrinsic, robust, and isolated flat bands present at half-filling in the minimal model of the superconducting metal-organic framework, Cu-BHT

Author: Miriam Ohlrich[1]

[1] *University of Queensland*

An analytical model of the metal-organic superconductor, Cu-BHT, shows that its simplified lattice structure possesses three robust, degenerate flat bands at half-filling, which are narrower and more isolated than those of twisted-bilayer graphene.

AIP: Nuclear and Particle Physics / 759

Rare leptonic B-decays at the Belle II Experiment

Author: Shanette De La Motte[None]

Co-authors: Cameron Harris [1]; Paul Jackson [2]

[1] *The University of Adelaide*

[2] *University of Adelaide*

We will summarise current searches within Belle II to identify the rare, leptonic B- decays $B+ \rightarrow \mu+\nu$ or $B0 \rightarrow \nu\bar{\nu}$ and detail how the upper bounds on experimental branching fractions of these rare decays will be improved.

AIP: Condensed Matter, Materials and Surface Physics / 761

Probing the Spatiotemporal Variation of Hyperfine Spin Properties in Fluorescent Molecular Materials

Author: Billy Pappas[1]

[1] *The University of New South Wales*

We spatially resolve hyperfine spin properties of organic materials employed in OLEDs to reveal large intra-device variations exceeding 30% and find this property to be correlated on lengths up to 7 μm.

AIP: Condensed Matter, Materials and Surface Physics / 762

Suppression of Phosphine-Protected Au9 Clusters Agglomeration on SrTiO3 Particles Using a Chromium Hydroxide Layer

Author: Abdulrahman S. Alotabi[1]

Co-authors: Greg F. Metha [2]; Gunther Andersson [3]

[1] *Flinders Institute for Nanoscale Science and Technology*

[2] *Department of Chemistry, University of Adelaide*

[3] *Flinders University*

The aim of this work is to investigate the inhibition of phosphine-protected Au9 clusters beneath a Cr(OH)3 overlayer to agglomerate under conditions of photocatalytic water splitting (i.e. UV irradiation).

AIP: Group for Astroparticle Physics / Astronomy / **763**

Cosmic relics from fundamental physics

Author: Archil Kobakhidze[None]

The isolated magnetic charges and primordial black holes are hypothetical cosmic relics that have a profound connection to some of the unresolved questions in fundamental science. I describe their origin and possible manifestations in astrophysical observations.

7th International Workshop on Speciality Optical Fibres / **764**

Optical fibers with NV nanodiamonds end-face coating for magnetic field sensing and imaging

Author: Adam Wojciechowski[1]

[1] *Jagiellonian University*

We propose a novel approach for remote sensing and mapping of magnetic fields with high spatial resolution using NV nanodiamond layer deposited on an end-surface of an optical fiber or an imaging fiber bundle.

AIP: Group for Astroparticle Physics / Astronomy / **765**

An observational perspective on tidal disruption events

Author: Adelle Goodwin[None]

I will provide an overview of observations of tidal disruption events - what happens when a star is destroyed by a supermassive black hole - including insights that these events enable into SMBHs and their surroundings.

AIP: Group for Astroparticle Physics / Astronomy / **766**

Latest Results on Ultra-High Energy Cosmic Rays from the Pierre Auger Observatory

Author: Bruce Dawson[1]

[1] *University of Adelaide*

In this talk I will describe the state of our understanding of the highest energy cosmic rays with a variety of results from the 3000 square kilometre Pierre Auger Observatory.

Conference on Optoelectronic and Microelectronic Materials and Devices / **767**

Design of High-Power near-2-μm Pumped Laser Diodes for Ho Fiber Lasers

Authors: Dominic Lane[1]; Nelson Tansu[None]; Alexander Hemming[2]; Heike Ebendorff-Heidepriem[None]; Glenn Solomon[None]; Jamie McInnes[None]

[1] *The University of Adelaide*

[2] *DST Group*

Holmium-doped high power fiber lasers operate at an eye-safe wavelength and have numerous applications. In this talk, we discuss a new method of optical pumping for this technology - using GaSb-substrate-based high power laser diodes emitting at 1950 nm wavelength.

7th International Workshop on Speciality Optical Fibres / 769

Hollow-Core Fibers for the Rise of Industrial Innovations

Author: Francois Chenard[1]

[1] *IRflex Corporation*

Silica hollow-core fibers (HCFs) are leading the way in advanced telecommunications and ultrashort pulse laser transmission. Chalcogenide HCFs will become the holy grail of CO2 laser transmission at 10.6 microns.

AIP: Atomic and Molecular Physics / 770

Non-equilibrium dynamics of a strongly interacting Fermi gas

Author: Paul Dyke[1]

[1] *Swinburne University of Technology*

We study the dynamics in a strongly interacting Fermi gas following a quench of the interactions. Using two-photon Bragg spectroscopy, we directly observe the amplitude oscillations, obtaining measurements of the pairing gap and damping rate as a function of temperature.

Poster session / 771

High-order image correlation spectroscopy for fluorescent nanoparticle microscopy

Author: James Chon[1]

Co-author: Delaram Katoozi [1]

[1] *Swinburne University of Technology*

We present a new theory of high-order image correlation spectroscopy capable of addressing emission QY distribution of fluorescence species, a common occurrence in silicon, plasmonic or semiconductor nanoparticle-based biolabellers.

Conference on Optoelectronic and Microelectronic Materials and Devices / **772**

Terahertz nanoscopy: a non-destructive characterization tool for nanomaterials and nanostructures

Author: Xiao Guo[1]

Co-authors: Aleksandar Rakić [1]; Karl Bertling [1]

[1] *The University of Queensland*

We employ terahertz scattering-type scanning near-field optical microscopy to quantitatively investigate the materials and structures in the nano-scale. We explore inorganic materials, contemporary electron devices, and biological nano-structures.

Conference on Optoelectronic and Microelectronic Materials and Devices / **773**

Hydration imaging with THz Quantum Cascade Lasers: Towards Precision Agriculture

Author: Aleksandar Rakić[1]

Co-author: Karl Bertling [1]

[1] *The University of Queensland*

Terahertz sensing holds promise for applications in precision agriculture due to the sensitivity of terahertz waves to hydration.
Here we present a laser-based terahertz imaging technique to evaluate temporal change of hydration in leaves.

Poster session / **774**

Coherent multi-mode dynamics of Terahertz Quantum Cascade Lasers in Fabry Perot configuration

Author: Carlo Silvestri[1]

Co-authors: Aleksandar Rakić [1]; Karl Bertling [1]

[1] *The University of Queensland*

Quantum cascade lasers emitting frequency combs are of interest due to the variety of novel applications they could support. Here we present a numerical study about the self-generation of these combs in the terahertz region.

Conference on Optoelectronic and Microelectronic Materials and Devices / **775**

Low-leakage Top-Gated Field-Effect Transistors with Epitaxial Graphene on SiC/Si pseudosubstrates

Author: Aiswarya Pradeepkumar[1]

[1] *University of Technology Sydney*

We address the challenges of growing epitaxial graphene on the 3C-SiC/Si system with our findings finally opening the possibility of obtaining dynamic tunability of charge transport in graphene on SiC/Si for integrated nanoelectronics and nanophotonics functionalities.

Poster session / **776**

Spectrally Resolving the Energy Dependence of Spin Processes in TADF OLEDs

Author: Billy Pappas[1]

[1] *The University of New South Wales*

We probe the distributions of spin properties responsible for reverse intersystem crossing in exciplex-based TADF OLEDs through spectrally resolved magneto-luminescence.

AIP: Group for Astroparticle Physics / Astronomy / **777**

The SKA Observatory: progress towards the next generation of radio astronomy

Author: Sarah Pearce[1]

[1] *SKAO*

The SKA Observatory will transform our understanding of the Universe. After decades of planning, construction of two telescopes is about to start in Australia and South Africa. Hear the latest on Australia's first mega-science project.

7th International Workshop on Speciality Optical Fibres / **778**

Volumetric integration of nanodiamonds in optical fiber cores

Author: Ryszard Buczynski[1]

[1] *University of Warsaw*

Optical fibers with NV(-) nanodiamonds embedded along the core are reported. Magnetic field sensing is validated along with nanodiamond concentration scaling and NV(-) fluorescence coupling to the guided modes.

7th International Workshop on Speciality Optical Fibres / 779

Can we produce high power visible light using doped silicate fibre?

Author: Stuart Jackson[1]

[1] *Macquarie University*

There is growing interest in developing visible light-emitting fibre lasers. Currently, they rely on fluoride-fibre but for some transitions silicate fibre may be suitable. Here I review silicate-based fibre lasers and offer ideas for allowing them to generate visible light.

7th International Workshop on Speciality Optical Fibres / 780

Specialty optical fibers for dispersion management in the spectral ranges of normal and anomalous material dispersion

Author: Svetlana Aleshkina[None]

The report discusses novel all-glass optical fibers designs for dispersion management and its applications.

Australian and New Zealand Conference on Optics and Photonics / 781

A Focal Plane All-fibre Wavefront Sensor

Author: Fiona Wei[None]

Adaptive optics (AO) is critical in astronomy, optical communications, remote sensing, and optical beam manipulation to correct distortions caused by propagation through media like the Earth's atmosphere or living tissue.

7th International Workshop on Speciality Optical Fibres / 782

Laser-based drawing of optical fibre

Author: Clarissa Harvey[1]

[1] *Royal Institute of Technology, Stockholm, Sweden*

This work explores using CO-laser heating to fabricate speciality optical fibre from unconventional materials. The unique temperature dynamics of this furnace demonstrated fine control of crystallisation in crystal-core glass-clad fibres.

Australian and New Zealand Conference on Optics and Photonics / 783

From Atom Mirrors to Atom Chips to Time Crystals

Author: Peter Hannaford[1]

[1] *Optical Sciences Centre, Swinburne University of Technology, Hawthorn, Victoria 3122, Australia*

We present an overview of recent research in our Atom Optics lab, including the development of magnetic optical elements for manipulating beams of ultra-cold atoms, magnetic microstructures, and time crystals using ultra-cold atoms bouncing on an atom mirror.

Australian and New Zealand Conference on Optics and Photonics / 784

The mechanisms and limitations to ultrashort pulse emission from mid-infrared fibre lasers

Author: Stuart Jackson[1]

[1] *MQ Photonics, School of Engineering, Macquarie University, North Ryde, NSW 2109, Australia*

Creating short pulses at mid-infrared (MIR) wavelengths has been an ongoing research area for several years because of the high applications potential. This talk will discuss different schemes for creating MIR ultrashort pulses in all-fibre configuration.

Australian and New Zealand Conference on Optics and Photonics / 785

Quantitative imaging of nuclear architecture and DNA target search in a living cell

Author: Elizabeth Hinde[1]

[1] *School of Physics, The University of Melbourne, Melbourne, Victoria 3052, Australiavvvvv*

Nuclear architecture has emerged as a key player in DNA search and maintenance of genome integrity. Recently we developed a series of fluorescence microscopy methods to track the movement of molecules around DNA networks within the nuclei of live cells.

Australian and New Zealand Conference on Optics and Photonics / 787

Towards room temperature quantum squeezing of a mechanical resonator

Author: Warwick Bowen[1]

[1] *University of Quensland*

Room temperature optomechanical squeezing would enable many applications in sensing and quantum computing. However, decoherence makes this challenging. I will present work which show large suppression of decoherence at low mechanical frequencies, opening a path towards room temperature quantum technologies.

Australian and New Zealand Conference on Optics and Photonics / 788

Astrophotonics: when astronomy meets photonics

Author: Sergio Leon-Saval[1]

[1] *Sydney Astrophotonics Instrumentation Laboratory, School of Physics, The University of Sydney, Sydney, NSW 2006, Australia.*

Astrophotonics lies at the interface of photonics and astronomical instrumentation. The power of photonics and Adaptive Optics, together with the development of new photonic devices, strengthens the case for astrophotonics year by year.

Australian and New Zealand Conference on Optics and Photonics / 789

New frontiers in smart sensor technology for a healthier, safer and sustainable future

Author: Benjamin Eggleton[1]

[1] *The University of Sydney Nano Institute*

Recent advances in device physics, nanotechnology, AI, and sensor fusion is leading to a revolution in smart sensor technology to provide multi-faceted interfaces to the three-dimensional physical, chemical, and data environment, enabling high-performance information gathering and real-time situational awareness.

Australian and New Zealand Conference on Optics and Photonics / 790

Topological plasmonics: Ultrafast vector movies of plasmonic skyrmions on the nanoscale

Author: Harald Giessen[1]

[1] *University of Stuttgart*

Here we introduce a new technique, time-resolved vector microscopy, that enables us to compose entire movies on a sub-femtosecond time scale and a 10 nm scale of the electric field vectors of surface plasmon polaritons. Depending on the shape and geometrical phase, in combination with the helicity of the excitation beam, topological plasmonic quasiparticles are created: skyrmions, merons, as well as quasicrystalline excitations. We observe their complete field vector dynamics at subfemtosecond time resolution.

Focus Session / 791

Topological nanophotonic metasurfaces

Author: Daria Smirnova[1]

[1] *Research School of Physics, Australian National University, Canberra ACT 2601, Australia*

Emulation of relativistic-like physics in photonic structures with Dirac spectrum has enabled observation of Klein tunneling and topological boundary modes in real and synthetic dimensions. We demonstrate another exciting emulation of trapped eigenstates of Dirac quasiparticles in photonic metasurfaces.

AIP: Quantum Science and Technology / 793

Chiral transport of hot carriers in graphene in the quantum Hall regime

Author: Glenn Solomon[1]

[1] *University of Adelaide*

Quantum Hall systems are of broad interest as they cover low-dimensional quantum systems, strong charge correlations, and topological physics. Our results lead to a unified understanding of the relaxation processes in graphene over different magnetic field strength regimes.

AIP: Quantum Science and Technology / 794

From quantum picturalism to quantum AI

Author: Bob Coecke[1]

[1] *Quantinuum Ltd.*

Our team have performed Quantum Natural Language Processing on an IBM quantum computer and our own trapped-ion hardware. Key to achieving this is the observation that quantum theory and natural language are governed by much of the same compositional structure.

AIP: Quantum Science and Technology / 796

Quantum computed moments – applications and prospects

Author: Lloyd Hollenberg[None]

The immediate prospects of solving real-world problems on near-term Noisy Intermediate Scale Quantum hardware is largely dictated by device noise/errors. We have developed an alternative approach to error mitigation strategies based on quantum computed moments to improve energy/cost function results.

AIP: Quantum Science and Technology / 797

Designing our future Quantum Internet

Author: William Munro[1]

[1] *NTT Basic Research Laboratories & NTT Research Center for Theoretical Quantum Physics*

The inherent differences between classical quantum physics means it is essential for us to establish how a quantum internet will operate, including the functionality required from quantum repeaters as well as the support our telecommunications internet will need to provide.

AIP: Quantum Science and Technology / 798

Testing Quantum Mechanics Underground in the Cosmic Silence

Author: Catalina Curceanu[1]

[1] *Istituto Nazionale di Fisica Nucleare*

We are experimentally investigating possible departures from standard quantum mechanics' predictions at the Gran Sasso underground laboratory in Italy. We are searching for signals predicted by dynamical collapse models, and signals indicating a possible violation of the Pauli Exclusion Principle.

AIP: Quantum Science and Technology / 799

Precision Metrology with Photons, Phonons and Spins: Answering Major Unsolved Problems in Physics and Advancing Translational Science

Author: Michael Tobar[1]

[1] *University of Western Australia*

This work includes: 1) Our study and application of putative modified physical equations due to beyond-standard-model physics, to determine possible new experiments; 2) An overview of our current experimental program, including status and future directions.

AIP: Quantum Science and Technology / 800

Recent breakthroughs in optical quantum computing with continuous variables

Author: Nicholas Menicucci[1]

[1] *Centre for Quantum Computation and Communication Technology, School of Science, RMIT University, Melbourne, VIC 3000, Australia*

Optical quantum computing with continuous variables offers the tantalising promise of room-temperature operation and vast scalability. Here I present an overview of recent key advances in scalability and fault tolerance with this platform.

AIP: Quantum Science and Technology / 801

Quantum Engineering with Levitated Systems

Author: Jason Twamley[1]

[1] *Okinawa Institute for Science and Technology*

I will discuss the advantages of magnetic trapping for trapping and cooling of nano-micron-scaled objects. This complete passive type of trap heralds the potential for low noise levitation and the creation of ultrahigh-motional-Q massive oscillators.

AIP: Quantum Science and Technology / 802

Sculpted Light and Applications

Author: Halina Rubinsztein-Dunlop[1]

[1] *The University of Queensland*

NA

AIP: Quantum Science and Technology / 803

Quantum processing made easier with a little help from bosons

Author: Gavin Brennen[1]

[1] *Macquarie University*

I'll describe protocols for simplified quantum processing on qubits using interactions mediated by quantized bosonic modes. These have applications for error mitigated quantum sensing and for non-local gates for low overhead quantum error correction.

Australian and New Zealand Conference on Optics and Photonics / 804

Optical Design, Simulation and Applications of 3d-printed Microoptics

Author: Alois Herkommer[1]

[1] *Universität Stuttgart*

Femtosecond direct laser writing as a 3D-printing technology has transformed the field of micro-optics. This paper highlights relevant aspects in the design of 3d-printed systems. It presents multiple design examples, ranging across micro-optical imaging-, illumination- and sensing-systems for various applications.

Australian and New Zealand Conference on Optics and Photonics / 806

Photonic chip frequency combs - new technologies to measure almost anything

Author: Arnan Mitchell[1]

[1] *Integrated Photonics and Applications Centre (InPAC), School of Engineering, RMIT University, Melbourne, Victoria 3001, Australia.*

This presentation will review the emerging science, technology, and applications of photonic chip frequency combs. This new form of laser light has the potential to bring unprecedented precision to almost any application that relies on measurement.

7th International Workshop on Speciality Optical Fibres / **807**

High Performance Large-Mode Area Double-Clad Fibers for kW Power Scaling of Fiber Lasers from 1 to 2.1 µm

Author: Clemence Jollivet[1]

[1] *Coherent-nufern*

Advances in Yb-doped and Tm-doped Double-clad LMA fibers to power-scale fiber lasers beyond multi-kW are presented, demonstrating > 3 kW at 1µm and > 65% slope efficiency at 2 µm.

7th International Workshop on Speciality Optical Fibres / **808**

Advances in High Power Fibre Lasers for Defence and Dual Use Applications

Author: Alex Hemming[1]

[1] *DSTG*

Fibre sources and metal-coated fibres are relevant to a range of dual-use applications. We will review DST work and highlight opportunities for collaborative programs based on these enabling technologies.

Fibre based sources present a compelling platform for the development of laser and amplifier devices to address a range of applications. The monolithic nature of fibre sources combined with demonstrated power scaling potential, excellent beam quality and narrow linewidth operation in particular enables their utility inareas such as materials processing, remote sensing, quantum physics and a range of scientific applications.
DST has developed a range of sources, in particular operating around 2 µm wavelength based on thulium and holmium doped fibres, as well sources based on the emerging platform of metal-coated fibres operating at wavelengths around 1 µm.

This presentation will review recent activities at DST in the areas of enabling component development, and the development of fibre sources focussing on thulium doped fibre and metal coated fibre architectures. The talk will highlight the dual use nature of the fibre sources and explore the potential opportunities for the development of collaborative programs based on these technologies.

7th International Workshop on Speciality Optical Fibres / **810**

Optically Cooled Yb-Doped Silica Fiber Lasers

Author: Michel Digonnet[1]

[1] *Stanford University*

This presentation will discuss recent breakthroughs in optical (laser) cooling of Yb-doped silica fibers using anti-Stokes pumping, and the exciting upcoming generation of silica fiber amplifiers and lasers that run cold.

7th International Workshop on Speciality Optical Fibres / 811

Polarization Maintaining Anti-Resonant Hollow Core Fiber

Author: Yingying Wang[1]

[1] *Institute of Photonics Technology, Jinan University, Guangzhou, China*

We summarize our recent results on design, fabrication and characterization of polarization maintaining anti-resonant hollow core fiber. Loss of 5.6 dB/km and phase birefringence of 1.8×10^{-5} is achieved.

AIP: Quantum Science and Technology / 812

Training quantum neural networks with an unbounded loss function

Author: Maria Kieferova[1]

[1] *University of Technology Sydney*

In this work, we examine the assumptions that give rise to barren plateaus in quantum neural networks and show that an unbounded loss function can circumvent the existing no-go results.

Australian and New Zealand Conference on Optics and Photonics / 813

Dispersion-diversity optical fibers

Author: Ivana Gasulla[1]

[1] *ITEAM Research Institute, Universitat Politècnica de València, Valencia, 46022, Spain*

Beyond high-capacity communications, space-division multiplexing fibers bring many advantages to optical and microwave signal processing, as not only space but also chromatic dispersion are introduced as new degrees of freedom.

Australian and New Zealand Conference on Optics and Photonics / 814

Towards the simplest quantum computation

Author: Kae Nemoto[1]

[1] *National Institute of Informatics, 2-1-2 Hitotsubashi, Chiyoda-ku, Tokyo 101-8430, Japan*

Based on the recent development of the quantum computer hardware, in this talk we present new quantum neural network models and show their performance for classification problems. We then discuss how far we can simplify such quantum computational systems.

Poster session / 816

Quantum Approaches to Combinatorial Optimisation Problems in the Automotive Industry

Author: Gary Mooney[1]

Co-authors: Bhaskar Bardhan [1]; Charles Hill [1]; Jedwin Villanueva [1]; Joydip Ghosh [1]; Lloyd Hollenberg [1]

[1] *University of Melbourne*

Quantum approaches to the binary paint shop problem – an optimisation challenge in the automotive industry – are investigated. We benchmark the quantum approximate optimisation algorithm and its recursive variant against classical heuristics and exact solvers

Precision and Quantum Sensing Workshop / 818

Quantum Sensors for Navigation and Mobile Gravimetry

Author: Philippe Bouyer[1]

[1] *Institute d'Optique (Nouvelle Aquitaine Branch)*

Today's challenge is to design compact, robust and mobile sensors which will lead to new generations of atomic sensors for mobile gravity mapping and GPS free navigation.

Precision and Quantum Sensing Workshop / 819

Optical Frequency Combs and Quantum Metrology

Author: Scott Diddams[1]

[1] *University of Colorado Boulder*

We explore and seek to define the standard quantum limit for metrology with optical frequency combs where the cyclostationary nature of the comb light impacts the shot-noise limited signal-to-noise ratio.

Precision and Quantum Sensing Workshop / 820

Quantum sensing from a distance through diamond-doped glass hybrid optical fibres

Author: Heike Ebendorff-Heidepriem[None]

This talk reviews fabrication strategies to embed diamond particles in fibres with respect to diamond and fibre properties and enhancing magnetic field sensitivity.

Precision and Quantum Sensing Workshop / 821

Quantum innovation in Australia

Author: Cathy Foley[1]

[1] *Chief Scientist of Australia*

In this keynote address, I will discuss opportunities for quantum innovation in Australia, barriers that need to be overcome, and strategies to build a strong quantum ecosystem to drive research up the value chain.

Precision and Quantum Sensing Workshop / 822

Sub-wavelength quantum imaging for astronomy

Author: Zixin Huang[1]

[1] *Macquarie University*

I will discuss recent advances in quantum imaging, and show how optimal measurement techniques that can allow us to surpass direct imaging precisions by several orders of magnitude.

Precision and Quantum Sensing Workshop / 823

Hybrid spin-phonon systems in diamond

Author: Ania Bleszynski Jayich[1]

[1] *University of California, Santa Barbara*

I present diamond optomechanical systems with high mechanical and optical quality factors and long spin coherence times of the embedded, strain-coupled defect centers. Progress towards reaching high spin-phonon quantum cooperativity is discussed.

Precision and Quantum Sensing Workshop / 824

System engineering quantum technology for defence applications

Author: Susannah Jones[1]

[1] *UK Defence, Science and Technology Laboratory*

System engineering quantum technology for defence applications, an overview of the Ministry of Defences (MoD) Defence science and technology laboratory (Dstl) quantum research portfolio.

Precision and Quantum Sensing Workshop / 825

Towards the realization of next-generation compact quantum sensors

Author: Michael Slocum[1]

[1] *US Air Force Research Laboratory*

We will discuss work ongoing within the US Air Force Research Laboratory developing supporting technologies, solid-state qubit materials and sensing approaches to realize and miniaturize ambient and room temperature quantum sensors.

Poster session / 826

Latest Developments on the Toroidal Analyser for Angle Resolved Photoelectron Spectroscopy at the Australian Synchrotron

Author: Anton Tadich[1]

[1] *Australian Synchrotron*

An update on the latest developments is given on the toroidal analyser for angle-resolved photoelectron spectroscopy at the Soft X-ray Spectroscopy beamline, Australian Synchrotron.

Focus Session / 827

Manipulating Low Dimensional Quantum Spin Systems for Future Spintronic Technologies

Author: Kirrily Rule[1]

[1] *Australian Nuclear Science and Technology Organisation*

In this talk I will discuss recent dynamic neutron scattering results from two natural minerals, linarite and atacamite, detailing the extent of our knowledge of these two copper oxide materials.

Focus Session / 828

Kitaev magnets and the search for the long-sought spin liquid state

Author: Stephan Rachel[1]

[1] *University of Melbourne*

In this talk, I first introduce the Kitaev spin liquid and discuss its properties. I present some stunning features such as the formation of Majorana fermion Landau levels.

Focus Session / **829**

Stability and Scaling Behaviour of Magnetic Skyrmions in Cu2OSeO3

Author: Clemens Ulrich[1]

Co-authors: E. P. Gilbert [2]; F. Pervez [3]; J. A. Sauceda Flores [3]; J. O'Brien [3]; J. Vella [4]; M. Spasovski [4]; R. Rov [4]; S. Yick [3]; T. Soehnel [4]

[1] *The University of New South Wales*

[2] *Australian Centre for Neutron Scattering*

[3] *UNSW Sydney*

[4] *University of Auckland*

The data provide new aspects about the scaling behavior of the skyrmion and helical distances. This offers new valuable information on the parameters in the spin Hamiltonian, which are responsible for the formation of the fascination quantum protected objects.

Focus Session / **830**

Form and function: magnetic excitations in strongly correlated electron systems

Author: Siobhan Tobin[1]

Co-authors: Andrew Boothroyd [2]; Dharmalingam Prabhakaran [1]; Jian-Rui Soh [2]

[1] *University of Oxford*

[2] *École Polytechnique Fédérale de Lausanne*

In this talk I will present work on the magnetic excitations of two contrasting strongly correlated electron systems.

Focus Session / **832**

From time crystals to time glasses

Author: David Cortie[None]

Here I briefly develop a theory of the experimental signature of a hypothetical time-crystal using neutron spectroscopy as a probe of the coherent dynamics in a lattice system, assuming a suitable driving mechanism such as intense terahertz light.

Focus Session / **833**

Correlation of polar functionality and structure dynamics of metal-organic framework perovskites

Author: Teng Lu[1]

Co-authors: David Cortie [2]; Dehong Yu [2]; Yun Liu [3]; Zuo-Xi Li [4]

[1] *Research School of Chemistry, The Australian National University, Canberra, ACT, Australia*

[2] *Australian Nuclear Science and Technology Organisation*

[3] *Australian National University*

[4] *Suzhou University of Science and Technology*

To reveal the critical role of the A-site molecular ions in the polarization-related properties, we investigate three MOFPs that have the same Mg(HCOO)3– frameworks with different molecular ions: [CH3NH3][Mg(HCOO)3] (MA-MOF), [(CH3)2NH2][Mg(HCOO)3] (DMA-MOF), and [C(NH2)3][Mg(HCOO)3] (GUA-MOF).

AIP: Condensed Matter, Materials and Surface Physics / **834**

Device design for detecting topological signatures in quantum wires

Author: Karina Hudson[1]

[1] *University of New South Wales*

In this talk we demonstrate how, using quantum point contacts (QPCs), we are able, for the first time, to carefully design devices with known electrostatic confinement dimensions, providing a pathway to scalable topological quantum hardware.

AIP: Condensed Matter, Materials and Surface Physics / **835**

Topological non-colinear magnetism in reduced sample dimensions

Author: Grace Causer[1]

[1] *Physik-Department, Technische Universität München*

In this talk I will discuss near-surface small-angle neutron scattering (NS-SANS), performed slightly above the critical angle of reflection, as a route to overcome the shortcomings of transmission SANS for extremely small magnetic sample volumes in the thin-film limit.

AIP: Condensed Matter, Materials and Surface Physics / 836

Materials for qubits: challenges of computer modelling for quantum technology

Author: Jared Cole[1]

[1] *RMIT*

The material science requirements for quantum computing are significantly more stringent than for conventional semiconductor electronics. I will discuss the fundamental challenges in simulating materials for this application, both generally and specifically for superconducting devices.

AIP: Condensed Matter, Materials and Surface Physics / 837

Spin gapless semiconductors — an emerging quantum matter for next-generation spintronic and electronics technologies

Author: Xiaolin Wang[1]

[1] *University of Wollongong*

I will introduce the concept of Spin gapless semiconductors (SGSs) and their unique features, highlighting the Dirac-type SGS which offers an ideal platform for massless spintronics and quantum anomalous Hall effect with a dissipationless edge state.

AIP: Condensed Matter, Materials and Surface Physics / 838

Organic molecular materials in one and two dimensions

Author: Jennifer MacLeod[1]

[1] *Queensland University of Technology*

I will discuss our recent work in using small molecule precursors to synthesize nanomaterials through on-surface reactions

Special session / 839

Tony Klein and Geoff Opat – pioneers of neutron optics

Author: Lloyd Hollenberg[None]

This talk will review the seminal work, and enduring legacy, of quantum pioneers Tony Klein and Geoff Opat in devising and performing the neutron-interference experiment which observed fermionic quantum phase acquired upon 2π rotation.

Special session / **840**

The He-McKellar-Wilkins phase shift, atom interferometry tests — recent work related to Aharonov Casher and Klein, Opat et al.

Author: Bruce McKellar[None]

In the dual HMW effect a topological phase emerges when electric dipoles pass around a line source of magnetic charges. When measured it also gave a much more precise measurement of the Aharonov Casher effect.

Special session / **841**

Atom Interferometry: Current technology and future directions from basic science to applications

Author: John Close[1]

[1] *Australian National University*

Atom interferometry offers stable, compact, primary sensing that can advance applications in ground water mapping, mineral exploration, planetary exploration and inertial navigation among other fields. I describe recent advances at ANU in techniques and applications.

AIP: Relativity and Gravitation / **842**

The cautious tale of GW200129: mimicking binary black-hole spin-precession with detector noise

Author: Ethan Payne[1]

[1] *California Institute of Technology*

The gravitational-wave observation of GW200129 hinted at the presence of spin-precession - an important observation for understanding black-hole binary formation. We discuss how this observation may instead be attributed to noise transients in the gravitational-wave detectors.

AIP: Nuclear and Particle Physics / **843**

First FRIB experiment: new microsecond isomer in 32Na discovered with the FDSi

Author: Timothy Gray[1]

[1] *Oak Ridge National Laboratory*

Results from the Facility for Rare Isotope Beams (FRIB) reveal the first microsecond isomer for exotic N=20 nuclei. Implications for nuclear structure and the competition between spherical and deformed shapes will be discussed.

Focus Session / **844**

Nuclear matrix elements from lattice QCD

Author: Phiala Shanahan[None]

I will discuss how first-principles lattice QCD calculations are yielding new insights into the structure and interactions of nuclei.

Focus Session / **845**

Hadron resonances in coupled-channel scattering from quantum chromodynamics

Author: David Wilson[1]

[1] *University of Cambridge*

Recent developments have enabled the computation of hadron resonance properties from scattering amplitudes determined from lattice Quantum Chromodynamics. We summarise this theoretical approach and compare with recent data from hadron physics experiments.

Plenary / **846**

Neutron stars and gravitational waves in the context of modern nuclear physics theory

Author: Jirina Stone[1]

[1] *University of Oxford/University of Tennesse*

Neutron stars,the densest known objects, form a rich laboratory for testing nuclear theories trying to describe the nuclear force. I will outline current approaches and their ability to impact the interpretation of gravitational waves arising from binary neutron star collisions.

Focus Session / **847**

Enhanced light emission and harvesting via disordered plasmonic metasurfaces

Author: Stefan A. Maier[1]

[1] *Monash University*

Disordered arrays of plasmonic colloids provide a means for broadband optical absorption, due to equipartition of energy and convergence of internal mode lifetimes. We examine such systems from the viewpoint of energy harvesting and enhanced light extraction.

Focus Session / **848**

Metaphotonics-enabled mid-IR spectrometers for chemical classification

Author: Kenneth Crozier[1]

[1] *University of Melbourne*

Mid-infrared spectroscopy has numerous applications. A host of new applications could be enabled by new types of mid-IR spectrometers with reduced size, weight, and cost. We will describe our recent work on a compact microspectrometer platform for chemical identification.

Focus Session / **849**

Chiral BIC Metaphotonics

Author: Cheng-Wei Qiu[1]

[1] *National University of Singapore*

We experimentally realize intrinsic chiral metasurfaces where the engineered slant geometry breaks both in-plane and out-of-plane symmetries. Our result achieves intrinsic chiral bound states in the continuum with near-unity CD of 0.93 and quality factor exceeding 2300 for visible frequencies.

Focus Session / **850**

Spontaneous Parametric Down-Conversion: from Micro- to Nanoscale

Author: Alexander Solntsev[1]

[1] *University of Technology Sydney*

The most common mechanism for entangled photon generation in optics is the second-order nonlinear process of spontaneous parametric down-conversion. I will provide a brief overview of recent developments in the area, moving from photonic chips to nanophotonics.

Focus Session / **851**

Graphene metamaterials for integrated photonic devices

Author: Baohua Jia[1]

[1] *RMIT University*

We developed scalable graphene metamaterials that show attractive optical and thermal properties. Through patterning with advanced laser nanoprinting technique, functional photonic devices with ultrathin, light weight and flexible nature have been demonstrated promising exciting opportunities for integrated photonics.

Poster session / **852**

System for Toxic Element Analysis (STELA)

Author: Jack Webster[1]

[1] *University of Wollongong / CSIRO*

The System for Toxic Element Analysis (STELA) is a new novel instrument designed for the measurement of toxic elements at significantly improved detection limits using highly advanced X-ray optics in conjunction with X-ray fluorescence analysis.

Poster session / **853**

LEvitated MAgnets for QUantum MEtrology

Author: Pavel Fadeev[1]

[1] *Johannes Gutenberg University, Mainz*

LEMAQUME is an EU-QuantERA project and aims to build a proof-of-principle prototype of a ferromagnet gyroscope. The precession of a magnet levitating in low magnetic fields allows for tests for exotic bosons, and, in the future, to the gyrogravitational ratio.

AIP: Education / **854**

How Teaching Students to "Think Like a Physicist" led to the ANU MakerSpace

Author: John Debs[1]

[1] *Research School of Physics, The Australian National University*

This presentation tells the story of how my hands-on approach to physics education led to the ANU MakerSpace – a highly successful, interdisciplinary, and openly accessible makerspace. I will share some highlights from my experience.

Poster session / **855**

Flavoured Peccei-Quinn symmetry and the DFSZ Axion

Author: Maaz Hayat[1]

[1] *University of Melbourne*

The DFSZ axion, which solves the Strong CP problem, suffers from a cosmological domain wall problem. In this talk, I provide a catalogue of domain-wall-free DFSZ-like axion models by modifying the structure of the Yukawa couplings based on symmetry principles

Poster session / **856**

Optimisation of electron spin qubits in electrically driven multi-donor quantum dots

Author: Abhikbrata Sarkar[1]

[1] *University of New South Wales*

2P:1P multidonor quantum dot EDSR qubit model, optimizing spin rotation and coherence. The model accounts for complete understanding of what impact qubit geometry and nearby charge defects have on the electrical operation and noise properties.

Plenary / **857**

From Nonlinear Optics to High-Intensity Laser Physics

Author: Donna Strickland[1]

[1] *University of Waterloo*

The laser increased the intensity of light that can be generated by orders of magnitude and thus brought about nonlinear optical interactions with matter. Chirped pulse amplification, also known as CPA, changed the intensity level by a few more orders of magnitude and helped usher in a new type of laser-matter interaction that is referred to as high-intensity laser physics. In this talk, I will discuss the differences between nonlinear optics and high-intensity laser physics. The development of CPA and why short, intense laser pulses can cut transparent material will also be included. I will also discuss future applications.

Plenary / **858**

Quantum sensing and imaging with diamond spins

Author: Ania Bleszynski Jayich[1]

[1] *University of California, Santa Barbara*

The diamond NV center offers a uniquely versatile path towards nanoscale imaging of condensed matter and biological systems. Here I present NV-based magnetic imaging experiments and discuss challenges to improved resolution and sensitivity, largely focused on materials engineering and tackling interface-induced decoherence.

Plenary / **859**

Silicon Photonic Quantum Computing – Towards Large-scale Systems

Author: Jeremy O'Brien[1]

[1] *University of Western Australia and PsiQuantum*

Many efforts around the world are now pursuing the ambitious goal of utility-scale, fault-tolerant quantum computing. Consistent themes are emerging across the field, as teams attempt to scale from existing small systems to the millions of qubits needed for useful applications. Systems partitioning, manufacturability, cooling power, networking, and control electronics are recurring challenges across all qubit technologies.

PsiQuantum has pursued a photonic approach, based on qubits implemented using optical photons propagating in lithographically fabricated waveguides. In this talk we will give a broad overview of recent technical progress, framed against these major scaling challenges. We will describe progress at the micro, meso, and macro-scale, including high-throughput test, semiconductor manufacturing, device performance, integration, packaging, control, and cryogenic systems. We will also present new architectural results pertaining to fault-tolerant compilation.

Plenary / **860**

From Quantum in Pictures to practical Natural Language Processing, Music, and understandable AI

Author: Bob Coecke[1]

[1] *Quantinuum Ltd.*

This talk requires no particular technical mathematics background, as I will talk entirely in terms of simple pictures. These are the pictures of my new book, "Quantum in Pictures" [1], which is aimed at the teenage enthusiast, and pretty much everyone else too - the book had a more technical predecessor [2].

One finds the same pictures in natural language, and much of the high-level reasoning that goes on in our brain can be shaped according to those pictures. One consequence of this is that natural language really wants to live on a quantum computer, which is something that we meanwhile realised [3], and we have also made music with quantum computers [4]. All our software developed for doing so, lambeq and Quanthoven respectively, is freely available from GitHub, open-source, and well-documented and well-supported. You can have a go yourself!

We show how these pictures also guide us towards a new form of natural language, one in which different languages all become the same. This in turns forms a new template for interpretable compositional AI.

[1] Bob Coecke and Stefano Gogioso (December 2022) Quantum in Pictures. Quantinuum Pubs.

[2] Bob Coecke and Aleks Kissinger (2017) Picturing Quantum Processes. Cambridge University Press.

[3] https://www.forbes.com/sites/moorinsights/2021/10/13/cambridge-quantum-makes-quantum-natural-language-processing-a-reality/

[4] https://thequantuminsider.com/2021/11/19/roll-over-quanthoven-can-quantum-computers-be-programmed-to-become-quantum-composers/

Plenary / **861**

The Coming Decade of Gravitational wave detection and astronomy

Author: Rana Adhikari[1]

[1] *Caltech*

The LIGO-Virgo-KAGRA network has detected approximately 100 merging compact objects using gravitational wave detection. The next series of upgrades promises increasing our understanding of highly warped spacetime, nuclear astrophysics, and cosmology. To reach those astrophysical targets, the measurements will have to be improved through quantum metrology, advances in thin film materials, and AI driven feedback controls.

Plenary / **862**

Educational Transformation at a Critical Time: The essential roles and promise of physicists

Author: Noah Finkelstein[1]

[1] *University of Colorado, Boulder*

Significant, perhaps unprecedented, attention is being paid to the needs for transformation within the fields of science, technology, engineering, and mathematics (STEM) education at the undergraduate level. This talk examines how higher education STEM disciplines, and physicists and physics departments in particular, are positioned to contribute to these discussions and address our challenges. I will review our own efforts in physics education transformation and the growth of work in physics education research (PER) at CU-Boulder as an example. Our work develops a new theoretical line of inquiry in physics education research through experimental work at the individual, the course, and the departmental scales. I present samples of these scales reviewing: how we can build on understanding of student reasoning to study and transform our introductory through upper division courses, studies of how our environments do and do not support women in physics, and models for engaging in sustainable and scalable transformation.

Plenary / **863**

The Dark Energy of Quantum Materials

Author: Laura Greene[1]

[1] *Florida State University*

The many correlated electron problems remain largely unsolved after decades; with one stunning success being BCS electron-phonon mediated conventional superconductivity. The Cooper pairing mechanisms of the dozens of families of unconventional superconductors, including the high-Tc cuprate, iron-based, and heavy fermion superconductors remain elusive and quite varied. But some of their fundamental characteristics are strikingly similar, including their ubiquitous phase diagram, with intriguing correlated electron (non-Fermi liquid) phases that break the symmetry of their underlying lattice at temperatures well above Tc. These correlated phases remain among the greatest unsolved problems in physics; and I will present an analogy stressing that. I will start with an overview of the US National MagLab and finish with some of our own recent work on identifying a possible new pairing mechanism in a heavy-fermion superconductor.

Plenary / **864**

Applications of nanophotonics — from bright colours to nanometrology and energy conversion

Author: Stefan A. Maier[1]

[1] *Monash University*

Structuring materials below the wavelength scale provides a means for light harvesting to nanometric dimensions. Particularly suitable are metallic nanostructures due to the existence of highly confined surface plasmon excitations, which allow efficient harvesting of electromagnetic energy and its transduction to other forms, for example acoustic surface waves or the supply of energy to catalyse chemical reactions.

Judiciously designed dielectric nanostructures can achieve similar energy concentration via the excitation of Mie-type resonances. In my talk, I will discuss a number of applications of these systems, from generation of structural colour to applications in energy conversion and nanometrology.

Plenary / **865**

Where Next in the Search for Dark Matter?

Author: Tracy Slatyer[None]

The nature of dark matter is an outstanding puzzle of fundamental physics. I will describe current limits on the broad space of viable dark matter scenarios, and outline some exciting directions for dark matter searches over the next decade, covering both terrestrial experiments and searches based on astrophysical observations.

Poster session / **866**

Enhanced room temperature valley polarization in WS2 excited above resonance.

Author: Kyle Boschen[1]

[1] *Swinburne University of Technology*

We use polarisation resolved photoluminescence to reveal enhanced valley polarisation of excitons on a ferromagnetic substrate. This indicates energetic splitting of the valleys induced by the magnetic field and potential magnetic exchange interactions.

Focus Session / **867**

Condensed Matter Physics in Big Time Crystals

Author: Peter Hannaford[1]

Co-authors: Ali Zaheer [1]; Andrei Sidorov [1]; Arpana Singh [1]; Chamali Gunawardana [1]; Krzysztof Giergel [1]; Krzysztof Sacha [2]; Satoshi Tojo [1]; Tien Tran [1]

[1] *Swinburne University of Technology*

[2] *Jagiellonian University*

We report the application of big discrete time crystals created by a Bose-Einstein condensate of ultracold atoms bouncing on an oscillating mirror to the investigation of condensed matter phenomena in the time dimension.

Focus Session / **868**

Realization of a discrete time crystal on 57 qubits of a quantum computer

Author: Philipp Frey[1]

[1] *University of Melbourne*

Here we report the observation of a discrete time crystal on a chain consisting of 57 superconducting qubits on IBM's quantum computer.

Focus Session / **869**

Clean Time Crystals in Kicked Lieb-Liniger Model

Author: Krzysztof Giergiel[1]

Co-authors: Bryan Dalton [1]; Jia Wang [1]; Krzysztof Sacha [2]; Peter Hannaford [1]

[1] *Swinburne University of Technology*

[2] *Jagiellonian University*

We present a theoretical study of clean time crystalline phases in the model of periodically kicked one-dimensional bosons with contact interactions on a ring.

Focus Session / **870**

Observtion of liquid time crystals

Author: Tapio Simula[1]

[1] *Swinburne University of Technology*

We have created Floquet driven time crystals comprised of gravitationally bouncing droplets of fluid. The persistent subharmonic response was observed for over one hundred thousand cycles. Topologically protected droplet transport in time has been realised.

Focus Session / **871**

Discrete symmetry-breaking and time crystals in continuous systems under periodic driving

Author: Jia Wang[1]

Co-authors: Bryan J. Dalton [1]; Krzysztof Sacha [2]; Peter Hannaford [1]

[1] *Swinburne University of Technology*

[2] *Uniwersytet Jagielloński*

We present a fully comprehensive multi-mode quantum treatment based on the truncated Wigner approximation to study discrete time crystals in continuous systems, such as a Bose-Einstein condensate
bouncing resonantly on an oscillating mirror.

Focus Session / **873**

Science with future Gravitational-wave Observatories: Cosmology

Author: Tamara Davis[1]

[1] *University of Queensland*

Gravitational waves offer a new precision tool for cosmology. I will discuss their advantages over previous light-based techniques, and the major conundrums that gravitational waves will illuminate such as cosmological "tensions", dark matter, and dark energy.

Focus Session / **874**

Science with future Gravitational-wave Observatories: Astrophysics

Author: Paul Lasky[1]

[1] *OzGrav Monash University*

What physics and astrophysics will we uncover with the next generation of gravitational-wave observatories? I will review the broad science case for future instruments, including tests of general relativity, relativistic and nuclear astrophysics, and extragalactic physics.

Focus Session / **875**

Cosmic Explorer and Einstein Telescope

Author: Bram Slagmolen[1]

[1] *OzGrav, ANU*

What detector design, configuration and infrastructure are required to reach the gravitational wave horizon? I will discuss the proposed next generation gravitational wave detector, Cosmic Explorer. I will review the instrumental challenges and potential realisation to construct such an observatory. The Einstein Telescope is European third generation gravitational wave detector. In this talk I will review the infrastructure and instrumentation design and the key challenges that it faces.

Focus Session / **876**

Status of current and medium term LIGO detectors

Author: David Ottaway[1]

[1] *University of Adelaide*

The current generation of GW detectors will soon begin their fourth observation run and plans are underway to upgrade the detectors until the start of third generation era. This talk will summarise the plans for the current generation of LIGO detectors.

Focus Session / **877**

Building NEMO, a Neutron star Extreme Matter Observatory in Australia

Author: Vaishali Adya[1]

[1] *Royal Institute of Technology, Sweden*

What technologies are needed to build a one-of-a-kind gravitational wave detector in Australia? I will present some of the key ingredients needed to build NEMO : a detector with sensitivity focused in the kHz regime.

Focus Session / **878**

What does Australia bring to the global gravitational-wave detector network

Author: Lilli Sun[1]

[1] *OzGrav, ANU*

What will a gravitational-wave detector in Australia bring us? We will discuss the contribution of an Australian detector to multi-messenger astronomy in the current and next generations of the global detector network.

Conference on Optoelectronic and Microelectronic Materials and Devices / **879**

Record-breaking performance of low-dimensional solid photodetectors – Commentary

Author: Antoni Rogalski[1]

[1] *Military University of Technology*

The purpose of this paper is to point out these unreliable photodetector parameters noted by the author and to try to draw attention to the obvious physical limitations of photodetectors that are sometimes overlooked in estimating photodetector performance.

Focus Session / **880**

The Culture of Physics and Research

An open panel discussion focusing on issues with the way physics research is currently conducted in Australia, along with how best to improve these practices to facilitate a more productive scientific culture. Panellists include Prof. Laura Greene (AIP plenary speaker, Florida State University), A/Prof Charlene Lobo (Head of Physics Discipline, University of Technology Sydney) and Prof. Trevor Harris (Ex-Discipline Lead at Defence Science and Technology).

Australian and New Zealand Conference on Optics and Photonics / 881

Clinical translation of optical imaging for surgical guidance - from bench to bedside

Author: Anita Mahadevan-Jansen[1]

[1] *SPIE President Elect*

This presentation will cover the translation of optical imaging to address challenges in endocrine surgery. Three different techniques will be used to (a) detect the parathyroid gland, (b) perfusion of the gland and (c) visualize the nerves during surgery.

Australian and New Zealand Conference on Optics and Photonics / 882

Light interacting with the vacuum

Author: Gerd Leuchs[1]

Co-authors: Luis L. Sánchez-Soto [2]; Margaret Hawton [3]; Vsevolod Salakhutdinov [1]

[1] *Max Planck Institute for the Science of Light*

[2] *Universidad Complutense de Madrid*

[3] *Lakehead University*

OPTICA Vice-President Keynote Talk

Authors: Gerd Leuchs 1,2,3, Vsevolod Salakhutdinov 1, Margaret Hawton 4, Luis L. Sánchez-Soto 1,5

1 Max Planck Institute for the Science of Light, Erlangen, Germany
2 Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany
3 Nexus for Quantum Technologies, University of Ottawa, Canada
4 Lakehead University, Thunder Bay, Canada
5 Universidad Complutense de Madrid, Spain

Abstract:
We treat the virtual particle-anti-particle pairs in the vacuum as two level quantum systems with a transition energy of 2mc^2, forming a dielectric and a diamagnetic. The approach describes the linear response explaining the parameters appearing in Maxwell's equations and also the non-linear response. This phenomenological model is largely compatible with quantum field theory, without leading to divergencies. The approach provides novel insight into the ubiquitous vacuum medium.

Short Bio:
Gerd Leuchs studied physics at the Universities of Cologne and Munich. His PhD-thesis dealt with

the fine structure splitting of sodium Rydberg atoms. He received the Habilitation degree at the University of Munich on multiphoton processes in atoms. After stays in the USA and Switzerland, Gerd Leuchs became full professor of physics at the University Erlangen-Nuremberg in Germany. Since 2009 he was director at the Max Planck Institute for the Science of Light and since 2011 he is professor adjunct at the University of Ottawa. He is member of the German and of the Russian Academy of Sciences and holds honorary degrees from Danish Technical University and St. Petersburg State University. He won the 2005 Quantum Electronics and Optics Prize of the European Physical Society and the 2018 Herbert Walther Prize, a joint award by Optica (formerly OSA) and DPG. In 2012 he was awarded the Cross of Merit of the Federal Republic of Germany and in 2018 he was appointed a member of Bavaria's Maximilian Order. Currently (2022) he is vice-president of Optica. His research spans the whole range from classical to quantum optics, with emphasis on the limits of focussing, on photon-atom-coupling and on quantum noise reduction of light.

Australian and New Zealand Conference on Optics and Photonics / 883

3D meta-optics: a new platform for wavefront shaping and optical sensing

Author: Haoran Ren[1]

[1] *Monash University*

Ultrathin meta-optics has transformed current photonic design. I will highlight a new 3D meta-optics platform with unleashed height degree of freedom. Design, 3D laser nanoprinting, and applications of various 3D metasurfaces will be discussed.

Bio:
Dr Haoran Ren is an ARC DECRA Fellow at Monash University. He joined Monash University in mid-2022, before that he held a Macquarie University Research Fellowship at Macquarie University, a Humboldt Research Fellowship at LMU Munich, and a postdoc position at RMIT University. His nanophotonics research seeks to uncover the underlying physics in structured light-matter interactions at nanoscale. His research group at Monash aims to develop advanced optical materials and nanotechnology to unleash the full potential of structured light in optical and quantum information processing. Ren is an Associate Investigator for the ARC Centre of Excellence for Transformative Meta-Optical Systems, and a member of the APL Photonics Early Career Editorial Advisory Board.

Australian and New Zealand Conference on Optics and Photonics / 884

New Approaches to Hybrid Fibers with Novel Functionalities for Sensing and Nonlinear Photonics Applications

Author: Heike Ebendorff-Heidepriem[None]

This talk presents recent progress in hybrid fibers with integrated functional materials such as diamond particles, 2D materials, high-index thin films or silk to create new intrinsic fiber properties for sensing and nonlinear photonics applications.

Short bio:
Heike Ebendorff-Heidepriem received the Ph.D. degree from the University of Jena, Germany, in 1994. Since 2005, she has been with the University of Adelaide, Australia. She currently leads the Fibres and Photonics Materials Research Group. She is the Deputy Director of the Institute for Photonics and Advanced Sensing and also the Director of the Optofab Adelaide Hub of the Australian National Fabrication Facility. Her research focuses on the development of novel optical glass materials and fibre structures.

Workshop on 3D Printing of Photonics Materials / 885

3D Printing Workshop

Details for the 3D Printing Workshop can be found at https://aip-congress.org.au/workshop.html

ANFF Workshop: Fabricating Photonic and Optical Components / 886

ANFF Workshop

Details for the ANFF workshop can be found at https://aip-congress.org.au/workshop.html

Poster session / 887

Microwaves with a twist: helical resonators for a new form of ultra-light darkmatter detection

Author: J. Bourhill[1]

Co-authors: E. Paterson [1]; M. Goryachev [1]; M.E. Tobar [1]

[1] *University of Western Australia*

Chirality is a fundamental property in many physical systems ranging from particle physics, topological and quantum systems, complex molecules and chiroptical phenomena. Many of these phenomena occuras surface states, at high energy and frequency, due to complex meta structures or plasmonic systems,which inevitably add loss. In this work we realise a new class of resonator, the Anyon cavity resonator,based on twisted and Möbius structures, which exhibit bulk chiral modes at radio frequencies with near unity helicity. We show that the modes naturally couple strongly to ultra-light dark matter axions with near unity form factors, equal to the square of the mode helicity. Ultra-light axions have been shown to solve the Standard Model strong Charge-Parity problem [1] and could account for the entire dark matter density of the universe [2], and are usually searched for using putative axion interactions with gluons and neutrons [3]. In contrast, ultra-light dark matter axion experiments proposed through the axion-photon chiral anomaly require two near degenerate photon modes, and are limited by how close in frequency the two modes can be tuned [4]. We show, due to the unique resonator properties, modes with non-zero helicity interact with the ultra-light axions causing an amplitude modulation, without the need for two seperate photon modes. This not only drastically reduces the complexity, but also opens up the possibility of utilising low loss superconducting resonators [5], allowing sensitive searches in the ultra-light mass range of 10−22to 10−14eV.

Poster session / 888

Constraining Beyond The Standard Model Nucleon Isovector Charges

Author: Rose Smail[1]

[1] *The University of Adelaide*

At the TeV scale, low-energy precision observations of neutron characteristics provide unique probes of novel physics. Precision studies of neutron decay observables are susceptible to beyond the Standard Model (BSM) tensor and scalar interactions, while the neutron electric dipole moment, d_n, also has high sensitivity to new BSM CP-violating interactions. To fully utilise the potential of future experimental neutron physics programs, matrix elements of appropriate low-energy effective operators within neutron states must be precisely calculated. We present results from the QCDSF/UKQCD/CSSM collaboration for the isovector charges g_T, g_A and g_S using lattice QCD methods and the Feynman-Hellmann theorem. We use a flavour symmetry breaking method to systematically approach the physical quark mass using ensembles that span five lattice spacings and multiple volumes. We extend this existing flavour breaking expansion to also account for lattice spacing and finite volume effects in order to quantify all systematic uncertainties.

AIP: Nuclear and Particle Physics / **889**

Search for Dark Matter in Invisible Higgs Decays with the ATLAS experiment

Author: Harish Potti[1]

[1] *University of Adelaide (AU)*

The nature of dark matter is still unknown and it is one of the key questions in particle physics. Many beyond the Standard Model theories predict the production of dark matter particles in the decays of the Higgs boson. As dark matter particles do not interact with the detector, they would be invisible to the detector and can only be probed using the presence of missing transverse momentum.

With full Run-2 data, the ATLAS experiment has performed six independent searches for dark matter in the invisible decays of the Higgs boson, each focusing on a different production mechanism and the final state. In this poster, I will present the results from the combination of these searches.

Focus Session / **890**

Quantum-light microscopy: evading biological photodamage via quantum correlations

Author: Warwick Bowen[1]

[1] *The University of Queensland*

It has long been predicted that quantum correlated light can improve microscopy. Here we show absolute performance advantage, using quantum corelated light to achieve clarity in bioimaging beyond the photodamage limit of conventional microscopy.

Focus Session / **891**

Quantitative imaging of intracellular topology

Author: Elizabeth Hinde[None]

Here we present results which demonstrate that the diffusive route of an inert fluorescent tracer reports intracellular topology and in particular and the real time accessibility of live cell nucleus architecture.

Focus Session / **892**

Biological sensing and imaging using Nitrogen Vacancy defects in diamond

Author: Melissa Mather[1]

[1] *University of Nottingham*

Nitrogen Vacancies in diamond nanoparticles are employed for in situ monitoring of the magnetic state of photomagnetic materials down to the single particle level, the stability of molecular cages containing atomic Nitrogen, and spin active products of photocatalysis.

Focus Session / **893**

Bioinspired Optical Cavities for Strong Light-Matter Interactions

Author: James Hutchison[1]

[1] *University of Melbourne*

This talk will outline recent studies of iridescent structures in a range of insects that may be of sufficient Q-factor to support strong light matter interactions. Sustainable and bio-degradable approaches to polaritonics will be discussed.

AIP: Condensed Matter, Materials and Surface Physics / **894**

Magnetic bandgap fluctuations in the intrinsic quantum anomalous hall insulator MnBi2Te4

Author: Mark Edmonds[1]

[1] *Monash University*

In this talk I will discuss using low-temperature scanning tunnelling microscopy and spectroscopy to measure the magnetic gap in 5 SL MnBi2Te4.

AIP: Atomic and Molecular Physics / **895**

Remembering Michael Brunger

Special session / **896**

Walter Boas winner, 2021

Author: Howard Wiseman[1]

[1] *Griffith University*

Special session / **897**

The Fabric of Space-Time

Author: Susan Scott[1]

[1] *The Australian National University*

The general theory of relativity, presented by Albert Einstein in 1915, has been well tested over the last century, and has led to far-reaching consequences, most of which were foreseen by Einstein himself. Two notable exceptions were that he did not predict the prevalence of space-time singularities throughout general solutions of the Einstein field equation, and although he knew that gravitational waves were a prediction of his theory, he believed that they were far too small for humanity to ever possibly detect them. In this talk I will discuss aspects of my ongoing research related to these two central, and evolving, subfields of general relativity.

Special session / **898**

Silicon continues to surprise with potentially powerful new properties and applications

Author: Jim Williams[1]

[1] *Research School of Physics, The Australian National University*

In recent years, it has been shown that silicon is not only the foremost electronic and photovoltaic material but can be structurally modified to dramatically enhance its properties and applications. This presentation highlights two such cases. First, silicon has been shown to possess up to 12 crystalline phases in addition to the equilibrium diamond cubic structure that has fueled the silicon chip revolution. These phases can be accessed by applying pressure, by using a diamond anvil cell, by indentation pressure, or even by femtosecond laser irradiation. Many of these phases are metastable at room pressure and temperature, and some have been shown to have interesting narrow bandgap semiconducting, as well as superconducting properties. Although such properties have not yet been exploited commercially, mainly as a result of scale-up limitations, they show considerable promise for novel applications. The second part of this presentation addresses a further area of novel silicon research, namely hyper-doping of silicon with transition metals to form dilute silicon alloys, that has been demonstrated to have important applications for near-infrared photodetectors. One such case, gold-hyperdoped silicon, possesses an intermediate band within the silicon bandgap that can be exploited for intriguing optoelectronic applications.

AIP: Atomic and Molecular Physics / **899**

There and Back Again: Demonstration and Future of an Optical Atomic Clock Beyond the Laboratory

Author: Sarah Scholten[1]

[1] *Institute for Photonics and Advanced Sensing, University of Adelaide*

Optical atomic clocks combined with the proliferation of compact optical frequency combs, offer higher inherent timing stability versus their current microwave counterparts. We detail the development and demonstrations of our portable optical atomic clock technology with bespoke comb outside the laboratory under rugged conditions, and outline future directions.

7th International Workshop on Speciality Optical Fibres / 900

Fabrication and Properties of Intrinsically Low Nonlinearity Optical Fibers.

Abstract:
This talk explores the fabrications processes and "many knobs" that must be turned to achieve low nonlinearity performance in modern optical fibers.
Active optical fibers that exhibit intrinsically low nonlinearities such SBS supression or increased TMI thresholds is the end research goal for many groups. Materially, these phenomena are well understood, as is the method to achieve the target thresholds.
Biography:
Dr. Hawkins is a Research Assistant Professor (since 2020) at Clemson University and the Optical Fiber Fabrication Lab Director (since 2012). He received his Ph.D. 2020 in Materials Science and Engineering from Clemson University.

Conference on Optoelectronic and Microelectronic Materials and Devices / 901

Integration of MEMS for Scalable Programmable Photonic Circuits

Author: Niels Quack[1]

[1] *The University of Sydney*

Our recent advances in wafer-scale integration of Micro-Electro-Mechanical Systems in Silicon Photonics have shown high performance tuneable couplers, filters, switches, and phase shifters that provide an advanced technology basis for emerging applications requiring very large-scale photonic integration such as programmable photonics.

Conference on Optoelectronic and Microelectronic Materials and Devices / 902

Development of 1550nm InAs on InP emitting QD Lasers

Author: Johann Peter Reithmaier[1]

[1] *European Physical Society*

Public lecture / 903

Cosmological Conundrums and the Dark Side of the Universe

Author: Tamara Davis[1]

[1] *University of Queensland*

What is expanding space? What came before the big bang? Is there an edge to space? What's beyond the horizon of a black hole? What can the amazing images from the James Webb Space Telescope tell us?

When I'm having a chat with family and friends, these are the questions I'm asked.

So upgrade your repertoire for cocktail party conversation by learning about these and other cosmological conundrums. You'll deep dive into the foundations of our cosmological model, mixed in with the latest updates on dark energy, black holes, and gravitational waves.

Australian and New Zealand Conference on Optics and Photonics / **904**

Diagnosing Skin Lesions – Malignant & Benign – with Light

Skin and prostate cancer have quite high incidence rates in New Zealand, Australia and the rest of the world. Identifying suspicious tissue for diagnostic and biopsy is a core challenge for treating both of these diseases. Optical spectroscopy offers rich datasets to improve the identification of diseased tissue. This presentation will discuss our recent advances.

Special session / **905**

The History and Future of IUPAP

Author: Bruce McKellar[None]

IUPAP was established in 1922 as the world was rebuilding itself after the 1914-1918 war. It has supported physics and physicists in the for the last 100 years, and will support them for the next 100 years.

Bruce was the President of IUPAP from 2014 to 2017, and is now the Past President on the Executive Council. He is emeritus Professor at the University of Melbourne.

Special session / **906**

IUPAP and the Changing Landscape of Science Diplomacy

Author: Laura Greene[None]

Science Diplomacy is moving to pay more attention to the implications for scientists in today's changing societal and geopolitical landscapes. IUPAP has recently issued statements in to address this.

Laura is the Chief Scientist at the US National High Magnetic Field Laboratory and the Marie Krafft Professor of Physics at Florida State University. She is a member of the US President's Council of Advisors on Science and Technology and the IUPAP Vice President for Ethics and Outreach

Special session / **907**

IUPAP Working Groups

Author: Anthony Thomas[None]

In addition to its Commissions IUPAP has a number of Working Groups which aim to focus and develop new research fields and activities that would be difficult to resource through traditional methods. The Working Group on International Cooperation in Nuclear Physics (WG.9) will serve as an example what these groups can achieve.

Anthony is the Elder Professor of Physics at the University of Adelaide. From 2004-2009 he served as Chief Scientist at the Thomas Jefferson National Accelerator Facility in the United States. He was President of the AIP from 1991-93, served six years as secretary of the IUPAP Commission on Nuclear Physics, was the inaugural Chair of IUPAP WG.9 and is currently Vice-Chair of the Asian Nuclear Physics Association.

Special session / **908**

Discussion

Special session / **909**

Preparing and sustaining physics educators (including discussion)

Author: Noah Finkelstein[1]

[1] *University of Colorado, Boulder*

Short keynote (10-15 mins) from Noah Finkelstein
Round-table discussion
Q&A session

Poster session / **910**

UV emission from lanthanide-doped upconversion nanoparticles in super-resolution microscopy: potential for cellular damage

Author: Afshin Karami[None]

Co-authors: Christopher J. Sumby [1]; Jingxiu Bi [2]; Stephen Kidd [3]; Thomas de Prinse [4]

[1] *Department of Chemistry and Centre for Advanced Nanomaterials, The University of Adelaide, Adelaide, 5005, Australia*

[2] *School of Chemical Engineering and Advanced Materials, The University of Adelaide, Adelaide, SA, 5005, Australia*

[3] *Australian Centre for Antimicrobial Resistance Ecology, Research Centre for Infectious Disease, School of Biological Sciences, The University of Adelaide, Adelaide, 5005, Australia*

[4] *The University of Adelaide*

"The upconversion nanoparticles (UCNPs) have recently attracted great attention as a fluorescence probe for use in super-resolution microscopy (SRM). This is due to the advantages of UCNPs over other fluorescence probes such as fluorescent proteins owing to their unique optical properties, lack of photobleaching and sharp emission peaks. However, the ultraviolet (UV) light that can be emitted from the UCNPs has been overlooked in most studies. The potential cell photodamage caused by UV light has been proven a limiting factor for in-vivo analysis. Here, UCNPs synthesised with eight commonly used combinations of Yb/Tm and Yb/Tm/Gd doped UCNPs were excited by pulsed and continuous wave (CW) lasers to evaluate their UV emissions. The UV-A and UV-B ratios were measured relative to the blue light emission at 475 nm which is traditionally used for imaging during SRM. We demonstrate that most samples generated UV light and that the dopant concentration has a key role in generating UV emissions. In addition, the usage of a pulse or CW laser for a similar UCNP sample can lead to large variations in the amount of UV emission produced. The results from this study highlight the importance of upconversion dopant concentration design as well as undertaking fluorescent analysis on synthesised UCNPs before their use to prevent unwanted cell photodamage during in vivo images taken with SRM."

Poster session / **911**

Constraining SWIMP parameters from late decay of WIMPs

Author: Meera Deshpande[1]

Co-authors: Anthony Williams [2]; Dipan Sengupta [2]; Martin John White [3]

[1] *The University of Adelaide*

[2] *University of Adelaide*

[3] *University of Adelaide (AU)*

SuperWIMPs form a popular class of cold dark matter that naturally inherit the desired relic density from the late decays of the WIMPs. We use cosmological probes like spectral distortions, BBN and Warm Dark Matter bounds to find constraints on generic SWIMP masses and couplings.

Poster session / **912**

Hyperon transition form factors from lattice QCD

Co-authors: James Zanotti [1]; Roger Horsley [2]; Ross Young

[1] *The University of Adelaide*

[2] *University of Edinburgh*

An alternative method for calculating Hyperon transition form factors in Lattice QCD which is based on the Feynman-Hellmann method is formulated. Results from this method are presented for the form factors of the Sigma to neutron transition as well as a comparison to results from the more common three-point function method.

Poster session / **913**

Hadronic Parton Momentum Fractions from Feynman-Hellmann in Lattice QCD

Author: Tomas Howson[1]

Co-authors: James Zanotti [1]; Roger Horsley [2]; Ross Young

[1] *The University of Adelaide*

[2] *University of Edinburgh*

A method to extract and non-perturbatively renormalise the quark and gluon momentum fractions of hadrons is demonstrated, based on the Feynman-Hellmann method applied directly to the gluonic contribution. Results from the application of this method in the presence of dynamical quarks are presented.

Poster session / **914**

Rare Leptonic Decays at Belle II

The Belle II Experiment is a high-energy collision experiment located in Japan, aiming to record the largest dataset of B-mesons ever produced.

B-mesons provide an unique laboratory to explore phenomena both within and beyond the Standard Model, such as quark-mixing, flavour oscillation and charge-parity violation.

Searches for leptonically decaying B mesons can provide a method of measuring these phenomena. The rarity of these leptonic B-decays, as well as their potential for incomplete energy signatures via a non-interacting neutrino call for novel techniques to ascertain their existence.

This poster will summarise the efforts within the Belle II Experiment to identify missing energy leptonic B-decays, performed with semileptonic B-tagging via the Full Event Interpretation machine learning technique.

An exploration of selection criteria to enhance signal to background ratios in key variables of interest will be presented, as well as an estimate on the number of events we could expect the Belle II Experiment to identify in its 2019-2022 dataset.

Focus Session / **915**

Need for a national effort in building nuclear and radiation science capabilities.

Focus Session / **916**

Medical Physics Workforce and Australia's role in Asia-Pacific

Focus Session / **917**

Radiation oncology in Australia: progress and possibilities

Author: Scott Penfold[1]

[1] *Australian Bragg Centre for Proton Therapy and Research, and University of Adelaide.*

Focus Session / **918**

National vision for nuclear science and applications: A Western Australia perspective.

Author: Gary Hale[1]

[1] *Curtin University*

Focus Session / **919**

Exploring fundamental science at the intersection of atomic and nuclear physics

Focus Session / **920**

Radiation and the mining industry.

Author: Nigel Spooner[1]

[1] *The University of Adelaide*

Focus Session / **921**

The national vision for nuclear science and applications: An ANSTO perspective

Author: Ceri Brenner[1]

[1] *Australian Nuclear Science and Technology Organisation*

Focus Session / **922**

Scale and Excellence: Building a Nuclear Engineering Industry in Australia

Author: Edward Obbard[1]

[1] *University of New South Wales*

Focus Session / 923

Radiation Protection – the challenges of keeping up with demand

Author: Cameron Jefferies[1]

[1] *Australasian Radiation Protection Society.*

Focus Session / 924

Discussion

Focus Session / 925

Interactive Round-Table Discussion

7th International Workshop on Speciality Optical Fibres / 926

WSOF Closing Ceremony

Focus Session / 928

Discussion

SASTA / 929

Education in Physics: Igniting passion for physics: students, teachers and academics

Format: 15 minutes Talks from experts in the field + Q&A. University professors & high school teachers
Description: Excitement in Physics is infectious, and it draws people in. For example, Paul Hewitt became known for his passionate and fun way advocating for physics and inspiring many students. Dianna Cowern, an MIT graduate, became a YouTuber known as 'Physics Girl'. Brian May, the league guitar player for the band Queen and a Ph.D. in Astrophysics, worked in interstellar gases, measured the rate of the rotation of galaxy.
How can we as teachers become passionate and how can we inspire our students?
Presenters:
1. A. Prof Trevor Harris - PhD FAIP - The University of Adelaide
2. Prof. Derek Abbott - Electrical and Electronic Engineering - The University of Adelaide
3. Zahra Pirvali – STEM coordinator and Senior Physics teacher at University Senior College, The

University of Adelaide
4. Prof. Eva Bezak - Medical and Nuclear physics - University of South Australia

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SASTA / 930

Teaching and Learning Modern Physics: Quantum Physics and / Relativity

Format: 20 minutes workshops by the university professors
Description: Modern physics requires an adequate use of models and a deep conceptual understanding of the underlying abstract ideas. The Physics curriculum in high schools and introductory university courses contains, at best, a passing reference to 20th Century physics. How have teachers and students adapted their conceptual frameworks towards incorporating the highly non-classical issues of modern physics? Do they appreciate the topics of interest to contemporary physicists, the contribution of physics to modern thought or the connection between the Physics they learn and modern technology? Examples include the Laser, Quantum technologies, LED, Large Hadron Collider, gravitational waves,
How can we stimulate greater interest and encourage our students to pursue their studies of physics further?

Presenters:
1. Professor Peter Veitch - Leader of the University of Adelaide node of the ARC Centre of Excellence for Gravitational Wave Discovery (OzGrav), The University of Adelaide
Topic of Presentation: Gravitational Waves
2. Professor Halina Rubinsztein-Dunlop – ARC CoE for Engineered Quantum Systems, School of Mathematics and Physics, The University of Queensland.
Topic of Presentation: Upcoming Quantum Technologies
3. Prof Kishan Dholakia - ARC Laureate Fellow at the Institute for Photonics and
Advanced Sensing (IPAS) - The University of Adelaide Topic of Presentation: Quantum Sensing

https://www.sasta.asn.au/blog/2022/11/15/24th_australian_institute_of_physics_congress

SASTA / 931

Space: Is Australia ready for the next generation of space innovations?

Format: Panel consisting of some experts in the field and a facilitator
Description: Will Australia be ready for the next generation of space innovations?
Space science and technologies is one of the most rapidly-growing, highly-diverse areas in Australia that needs new people in it. It's a growth industry and we need Australians to contribute to it. That takes focus and investment. Space is more accessible now than it has ever been. We can have small and large private companies building and launching systems into space that can monitor the Earth and space environments. Australia would benefit from strong investment in space science research and development. One of the most exciting things about space science is the amazing technologies and applications that we can create to improve life on Earth. The Australian Academy of Science has released a 10-year plan for space science, calling on the federal government to prioritise innovation while protecting our sovereign interests.
Each panellist will present their views in the context of their field and address:
Will Australia be ready for the next generation of space innovation? Is our current education system capable of serving this future need? What will need to change in the education system? And how do we make this happen?

Panellists:
1. Associate Professor Alice Gorman – Space Archaeology and Exploration- Flinders University
2. Dr Saeed Salimpour- Post-Doctoral Researcher/Former High school teacher - Astronomy Education Research Coordinator - IAU OAE(MPIA)/Deakin University
3. Professor Richard Turner - Serial Entrepreneur including Founder ZEN Energy | Author of "The Essential Entrepreneur" Book & Online Platform | Deputy Chair of Premier's Climate Change Council | Board Member
4. Nate Taylor - Australian Space Agency
5. Facilitator: Elizabeth Pearce - Australian Space Agency

https://www.sasta.asn.au/blog/2022/11/15/24th_australian_institute_of_physics_congress

Conference on Optoelectronic and Microelectronic Materials and Devices / 932

Metamorphic growth for 1550 nm quantum dots by molecular-beam epitaxy.

Author: Fauzia Jabeen[1]

[1] *University of Würzburg*

Australian and New Zealand Conference on Optics and Photonics / 933

Silicon-Germanium Ring Resonator on-Chip with High Q-Factor in the Mid-Infrared

Author: Marko Perestjuk[1]

[1] *RMIT University & Institut des Nanotechnologies de Lyon*

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Abstract:
We demonstrate an on-chip high-Q ring resonator in the mid-infrared with a loaded Q-factor above 200,000. This was achieved around 4.18μm wavelength on a CMOS-compatible silicon-germanium platform, whose strong nonlinearity makes the rings ideal candidates for Kerr comb generation

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Direct Detection of Multi-Component Dark Matter with Gravitational Focusing

Author: Bill Loizos[None]

We motivate a dark matter model correction, due to the sun's gravity, in which direct detection experiments are expected to exhibit a non-sinusoidal signal. We also explore the dark sector consisting of more than one distinct mass component.

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Discussion

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Welcome