Research Report

Professor Ken Baldwin
Deputy Director (Research)

The Research School of Physics and Engineering (RSPE) is the largest university-based institution in the country for physics research by some measure, with 163 academics, 110 professional staff and 164 post graduate students.

Physics at ANU has achieved the highest rank in in the Excellence for Research in Australia ranking (ERA level 5). In 2013, ANU Physics was also the highest ranked Australian physics department (28th in the world), and the highest in any discipline in Australia according to the Shanghai Jiao Tong Academic Ranking of World Universities (ARWU).

The School's research in selected areas of strength covers the entire spectrum from fundamental research through to applied research and pre-commercial development. The research program is built around three "big picture" themes: quantum science and technology; advanced materials and technology, and energy and environmental science and technology. The research program is not only confined to the discipline of Physics, as the School has significant links with Engineering, Chemistry, Astronomy, Earth Sciences, Mathematics and other scientific disciplines.

The School continued to excel in its research performance in 2013, with almost 500 journal publications and 150 international conference publications. In 2013 the School was successful in winning over $25 million in research grants including over $15 million from the Australian Research Council, with the remainder comprising funds from the Education Investment Fund (EIF), National Collaborative Research Infrastructure Strategy (NCRIS), Australian Space Research Program (ASRP) and industry.

RSPE hosts three major national facilities supported by EIF and NCRIS funding: the National Plasma Fusion Research Facility (H-1NF), the Heavy-Ion Accelerators Facility (HIAF), and the ACT node of the Australian National Fabrication Facility (ANFF). RSPE is also part of the Australian Nanotechnology Network (ANN).

The School is a partner in three ARC Centres of Excellence: the Centre for Antimatter-Matter Studies, the Centre for Quantum Computing and Communications Technology (CQC2T) and the Centre for Ultrahigh Bandwidth Devices and Optical Systems (CUDOS).

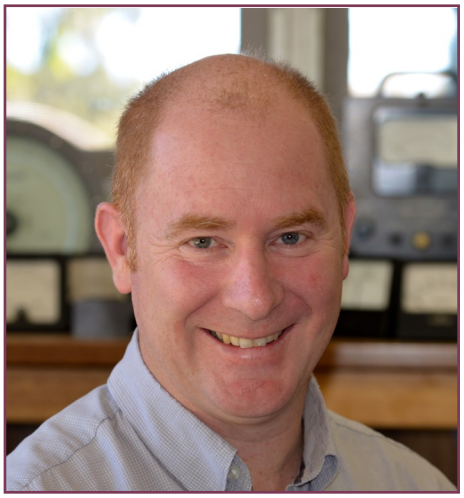
In 2013 the School was successful in being awarded 2 Future Fellowships, 1 DORA Fellowship and 2 DECRA Fellowships. RSPE also was awarded 16 ARC Discovery and 1 Linkage grants for physics research.

RSPE is comprised of ten research departments. A brief description of each department is detailed in the following pages as well as a list of staff dedicated to that area.

Professor Ken Baldwin is Deputy Director (Research) of RSPE, as well as being Director of the ANU Energy Change Institute, and a Professor in the Department of Atomic and Molecular Physics, RSPE.

Applied Mathematics

Professor Tim Senden
Head of Department



It is was another year to celebrate diversity, with 2013 seeing a number of significant events to mark the long term commitments from, and to, our staff and students. The year started with the announcement of an exciting new Devonian predator, a 6 metre monster in PLOS ONE. While this was the result of a long collaboration between Research School of Earth Sciences it illustrates the breadth of collaborations across campus and beyond. In 2013 many of these collaboration evolved to their next level of sophistication. It is with that warmth a retrospective view can bring that I sense the Department is again shifting and adapting to meet new challenges.

In last year's report I highlighted how instruments such as the Heliscan CT are a symbol of where technical excellence intersects academic innovation. This productive union of professional and academic staff led to the installation of a facility in Qatar, in May, and cements a long relationship with Maersk Oil found via the Digicore Consortium. Fast-forwarding to November the same Consortium saw a record membership of 14 companies join us in Canberra for the annual meeting. This is one of the largest university consortia in the world and demonstrates the funding agility which can only derive from investing in fundamental research.

Throughout 2013 Canberra celebrated it's centenary and as part of that program our resident artist, Erica Seccombe and Ajay Limaye (National Computational Infrastructure) were invited to exhibit their long-term collaboration based around data from our CT facility. Earlier, Erica had been awarded the inaugural VC's College Artist Fellowships to further develop her connection with our Department. In August they installed an entrancing animated and utterly 3D exhibition at the Canberra Contemporary Art Space called "Monster!" It attracted one of the largest crowds the Art Space has seen with a combination of large screen stereo visualisations and surreal, fluorescent 3D prints of a common garden slater. Also in August we celebrated the announcement of the Sirtex Chair, the first industry sponsored Chair at the ANU and proudly held by Professor Ross Stephens. He and his group have forged a remarkably rewarding engagement with the fastest growing Australian biotech, Sirtex Medical. Their CEO, Gilman Wong, was glowing in his dedication to Ross and the talents of his group, located in Research School of Biology. Again, it seemed another public triumph for the Department to see fundamental work find such meaningful application. The end of August marked an opportunity to assemble around a tribute to our founding Head of Department, Professor Barry Ninham. World-renowned sculptor, Ante Dabro, graciously rendered Barry's bust and so immortalised some of the essence of our Department.

In the long awaited conclusion to Teon Castle's PhD his spectacular thesis, "Entangled graphs on surfaces in space", untangled many problems in knot theory. Francesco Pozzi submitted an impressive thesis in Econophysics entitled, "Optimal Filtering Financial Networks and Optimal Portfolio Selection". We welcomed 4 new students in 2013 into fields ranging from specific ions effects to upscaling petrophysical properties.

Just as the year commenced with an evolutionary landmark it seemed to be ending with another. Our spin-off company, now Lithicon, was being wooed by a major global company. Having merged the year before with the Norwegian counter-part, Lithicon was attracting great attention throughout 2013 and in the last days of the year exciting prospects loomed, imminent for 2014. Stay tuned.

Academic Staff

Head of Department and Professor

Tim Senden BSc PhD

Professors

Vince Craig BSc PhD, ARC Future Fellow

Stephen Hyde BSc PhD Monash

Mark Knackstedt BSc Columbia, PhD Rice (on leave, Digitalcore Pty Ltd)

David Williams BSc Sydney, PhD Cambridge

Emeritus Professors

Barry Ninham MSc WA, PhD Maryland, DTech (hon causa) KTH Stockholm D Phil (hon Causa) Lund, FAA

Stjepan Marcelja, Diplng Zagreb, PhD Roch, FAA

Senior Fellows

Adrian Sheppard BSc Adelaide, PhD, ARC Future Fellow

Research Fellows

Lilliana De Campo BSc PhD Graz

Andrew Fogden BSc PhD Docent Lund

David King BSc

Drew Parsons PhD

Vanessa Robins BSc, PhD Colorado

Ross Stephens PhD Sydney

Postdoctoral Fellows

Hongjie An PhD

Andrew Kingston PhD Monash

Shane Latham BSc PhD UQ

Glenn Myers PhD Monash

Benoit Recur PhD Bordeaux (from June)

Mohammad Saadatfar PhD

Andrea Salis PhD Cagliari (from June)

Visiting Fellows

Dr Linnea Andersson, Stockholm University (until February)

Dr Christoph Arns, University of NSW

Dr Tomaso Aste, University of Kent (until January)

Dr Mathais Bostrom, Linköping Universitet Sweden (until April)

Dr Anna Carnerup, Digitalcore Pty Ltd

Dr Judith Caton

Dr Andy Christy

Mr Arthur Davies

Prof Phil Evans, University of British Columbia

Dr Olaf Delgado Friedrich (from May)

Dr Wilfred Fullagar (from June)

Dr Ankie Larsson (from September)

Prof John Maloney (until April)

Dr Rainer Mittlebach

Prof Norman Morrow, University of Wyoming

Dr Shannon Notley, Swinburne University

Dr Gerd Schröder-Turk, University of Erlangen

Dr Rob Sok, Digitalcore Pty Ltd

Professional Staff

Senior Software Designer

Paul Veldkamp BSc BEc

Head Technical Officer

Tim Sawkins

Technical Officers

Holger Averdunk

Jessica Bell (nee Blackmore)

Ron Cruikshank

Stuart Hungerford (from January)

Karen Knox (from August)

Rohini Marathe, BSc Mumbai, MSc Rutgers

Michael Turner PhD

Contractors

Levi Beeching (CT sales)

Joe Micallef (CT sales)

Roderick Vagg

Departmental Coordinator

Martina Landsmann

Students

PhD

Pieter Botha (from January)

Qianhao Cheng (from January)

Toen Castle

Vivianne Deniz

Timothy Duignan

Namsoon Eom(from August)

Shaun Howard

Heyang Li

Thomas McKay

Min-Chul Kim

Virginia Mazzini (from May)

Jill Middleton (until January)

Mahsa Paziresh

Francesco Pozzi (until August)

Stuart Ramsden (until September)

Mehdi Shabaninejad

Alison Sham

Tao Song

Ponlawat Tayati

Johnny Valbuena Soler

Rick Walsh

Visiting Students

Henri Der Sarkissian, University of Nantes, France

Koen Deuss, Technische Universiteit Eindhoven, The Netherlands

Michael Fischer, Universität Erlangen-Nürnberg, Germany

Mayam Hanifpour, Teheran University, Iran

Mehdi Alizadeh, University of New South Wales

Tianshu Liu, Australian National University

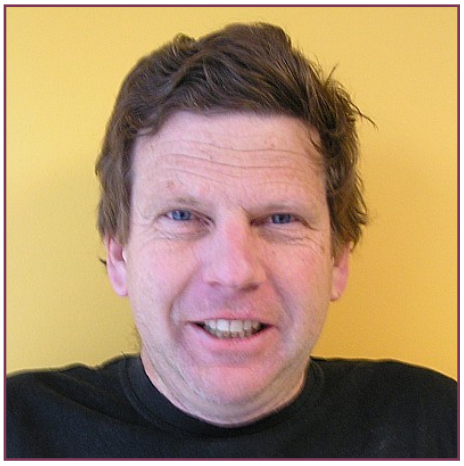
Erica Seccombe, Australian National University

Jin Tao, Australian National University

Qi Ziyuan, China University of Petroleum (Huadong), P.R. China

Atomic & Molecular Physics

Dr Maarten Vos
Head of Department



The Atomic and Molecular Physics Laboratories (AMPL) are engaged in a broad range of experimental and theoretical studies of the interaction of electrons, positrons, and photons with atoms, molecules and solids as well as the internal structure of a new state of matter: Bose-Einstein condensates. Our goal is both to further our knowledge of fundamental physical and chemical processes, and to provide information that is critical to applications in other scientific disciplines, technology, and the environment.

AMPL's research activities include photon interactions: VUV/XUV laser spectroscopy, laser photodetachment and photofragment spectroscopy, computational molecular physics, positron and electron interactions: low-energy positron and electron physics, materials studies with positrons and electrons, and computational studies of charged particle interactions, Bose Einstein condensation studies of helium atoms, atom manipulation, experimental tests of QED theory, and quantum-atom optics.

AMPL has a long tradition of developing new, cutting-edge experiments. Our outstanding technical staff is pivotal for the success of these developments. In this tradition, we are particularly excited that 2013 has seen the construction of a new experiment in the field of polaritronics, a state that is a mixture of light and matter (jointly with the Non-Linear Physics Centre). This experiment will complement our successful research in Bose-Einstein condensation of metastable helium atoms which have a similar high-degree of internal coherence.

New free-electron lasers are coming on-line overseas, producing extreme intensities of photons. Experiments using these sources reveal the intricate behavior of atoms in these strong photon fields. Theoretical results on attosecond science obtained in AMPL has been widely used by leading experimental groups including Max Born Institute, Berlin; Max-Plank Institute, Heidelberg, Vienna Technical University and ETH University in Zürich.

AMPL also hosts an Australian Research Council Centre of Excellence: the Centre of Excellence for Antimatter-Matter Studies (CAMS), which studies the interaction of positrons and electrons with matter. In 2013, positron research continued to focus on the study of biomolecules, relevant to processes important for better understanding PET scans. We also made the first attempts at an experiment, a positron reaction microscope, which was tested on the low energy positron beamline (jointly with the University of North Texas).

There is a strong interest in environmental and climate change issues. We study the molecular processes in the Venus atmosphere to enhance our understanding of what determines the climate on a planet. Calculations of the capability of the ALICE spectrometer on the NASA New Horizons probe, which will fly by Pluto in 2015, revealed that the spectrometer can measure nitrogen isotope ratios, of importance for the evolution of the solar system and galaxies. We are involved (together with the Fenner School of the Environment) in understanding cloud physics in order to forecast the output of rooftop photovoltaics. We also play an important role in the ANU Energy Change Institute.

Academic Staff

Head of Department

Maarten Vos MSc PhD Groningen

Professors

Kenneth Baldwin BSc MSc, DIC PhD London, FAIP, FInstP, FOSA, FAPS (2 April to 31 August)

Stephen Buckman BSc PhD Flinders, FAPS, FAIP, FIstP

Anatoli Kheifets BSc PhD St Petersburg, FAPS

Emeritus Professors

Robert Crompton AM FAA FAPS FAIP

Erich Weigold AM FAA FTSE FAPS FAIP

Brenton Lewis PhD DSc Adelaide, C Phys, FInstP, FAPS, FOSA, FAIP

Senior Fellows

Stephen Gibson BSc PhD Adelaide

Research Fellows

James Sullivan BSc PhD ANU

Andrew Truscott BSc PhD Queensland

David Sprouster BSc (Hons) Wollongong PhD ANU (to 26 November)

Robert Dall BSc Queensland PhD

Igor Ivanov PhD DSc Moscow

Mitsuhiko Kono MSc KyotoIT, PhD GUAS Tokyo (to 30 November)

Visiting Fellows

Dr Simon Armitage (University of North Texas)

Prof Michael Brunger (Flinders University)

Dr Steven Cavanagh (Defense)

Dr Sarah Chamberlain

Dr Luca Chiari (Flinders University)

Prof Hyuck Cho (Chungnam University)

Dr Jan Chwedenczuk (Unversity of Warsaw)

Prof Gustavo García Gómez-Tejedor (CSIC)

Dr Kandis Lea Jessup (Southwest Research Institute)

Dr Mitsuhiko Kono

Prof Robert McEachran

Prof Dennis Mueller (University of North Texas)

Adjunct Prof Robert Robson (James Cook University)

Mr Farshid Salehzahi (ACT Health)

Dr Vlad Serov (Saratov State University)

Dr David Sprouster (Brookhaven National Laboratory)

Prof Marek Trippenbach (Unversity of Warsaw)

Dr Suzanne Smith

Prof Ravi Rau

Professional Staff

CAMS Chief Operating Officer

Adam Edwards LLB Nottingham, BSc Wollongong, GDM Western Sydney, MAppFin Charles Sturt

Technical Officers

Stephen Battisson AssocDip MechEng CIT

Colin Dedman AssocDip SciInst Bendigo CAE

Ross Tranter

Departmental Administrator

Julia Wee BA Sydney, GCM MGSM

Students

PhD

Roisin Boadle

Colin Campbell

Jacob Hughes

Roman Khakimov

Andrew Geoffrey Manning

Joshua Machacek

Prasanga Palihawadana

Wade Tattersall

Ju-Kuei Wu

Henry Poetrodjojo

Honours & Other Scholars

Johannes Postler (Visiting student)

Andrew Ridden-Harper (Summer Scholar – University of Canterbury, NZ)

Sam Backwell (Summer Scholar – ANU)

Sabina Scully (Summer Scholar – ANU)

Joshua Petrass (honours-ANU)

Ashton Walker (honours-ANU)

Ly Duong (honours-ANU)

Electronic Materials Engineering

Professor Mark Ridgway
Head of Department

The Department of Electronic Materials Engineering (EME) conducts interdisciplinary research in condensed matter physics, materials science and device engineering. This includes world-class research in the growth, structure, properties and applications of electronic and photonic materials. Diversity is a key strength and underpins a broad collaborative base and an ability to attract students and researchers from a range of disciplines and countries.

2013 was another successful year for EME, now the largest department in the School. We welcomed numerous persons across the academic, professional and student sectors in addition to a multitude of short and long term visitors. EME personnel represent a broad range of scientific backgrounds and expertise and also a broad range of cultural and ethnic origins. Departmental staff and students are drawn from over 25 countries world-wide.

Successes this year included a range of promotions, awards, grants, fellowships, elections and appointments too numerous to list though details are provided below. The Departmental research programs and capabilities continued to expand including major upgrades to the MOCVD infrastructure such that EME now houses three state-of-the-art MOCVD reactors dedicated to the growth of III-V materials. Departmental staff and students continued to make significant contributions to the under-graduate teaching program including first-year life physics and third-year condensed matter physics. The integration of teaching and research further strengthens the Department and bodes well for the future of EME.

Academic Staff

Head of Department and Professor

Mark Ridgway BSc McM, MSc PhD Queens

Distinguished Professor & Australian Laureate Fellow

Chennupati Jagadish MSc, PhD Delhi, FAA, FTSE, FAIP, FInstP, FIoN, FIEEE, FAPS, FOSA, FSPIE, FECS, FIET, FAAAS, FAVS, FECS

Professors

Robert Elliman BAppSci MAppSci RMIT, PhD DSc Salford, FAIP, FIP

Hoe Tan BE Melbourne, PhD

Emeritus Professor

Jim Williams BSc PhD UNSW, FAA, FAIP, FIEAust, FTSE, FAPS, FMRS

Senior Fellows

Yin Yin (Jennifer) Wong-Leung BSc Bristol, PhD

Jodie Bradby BAppSc RMIT, PhD

Lan Fu MSc UTSC, PhD

Patrick Kluth DipPhys Düsseldorf, PhD Jülich

Fellows

Jiandong Ye PhD Nanjing

Qiang (Michael) Gao MS BSc NEU PhD

Philippe Caroff-Gaonac'h MSc U Louis Pasteur, PhD INSA de Rennes (from January)

Research Fellows

Sudha Mokkapati PhD

Dinesh Venkatachalam MSc BITS, PhD RMIT,

Kiran Mangalapalli M.Sc, PhD U of Hyderabad

Bianca Haberl PhD

Matias Rodriguez PhD (till December)

Postdoctoral Fellows

Boshra Afra PhD (June-December)

Steffen Breuer PhD HU (till August)

Yanan Guo PhD UQ (from June)

Felipe Kremer PhD UFRGS (till August)

Scott Medling BSc Caltech, MSc UC Riverside, PhD UC Santa Cruz (from October)

Shagufta Naureen (from June) PhD KTH Stockholm

Fang Fang Ren BSc, PhD NJU (from July)

Avi Shalav PhD UNSW, MSc DipTchg Massey

Pawel Sajewicz MSc Warsaw U of Tech, PhD UCC Tyndall

Hazar Salama PhD UNSW

Fan Wang PhD UNSW (from July)

Hao Wang MSc Jinan, PhD South China Normal (till September)

Visiting Fellows

Neville Fletcher AM, PhD Harvard, DSc Sydney, FAA, FTSE, FInst P, FAIP, FAAS. FASA

Haroldo Hattori (ADFA)

Simon Ruffell (Varian)

Leigh Smith U of Cincinnati (from December)

Research Assistants

Kidane Belay BSc MSc AAU Ethiopia, PhD

David Llewellyn (joint CMBE)

Professional Staff

Technical Officers

Michael Aggett AssocDipMechEng CIT

Josh Carr

Chris Kafer (from September)

Dane Kelly

Thomas Kitchen AdvDipMechEng (from September)

Departmental Administrator

Julie Arnold BA

ANFF

Manager

Fouad Karouta BSc LUB, PhD Perpignan, PhD Montpellier

Processing Engineers

Kaushal Vora PhD Latrobe

Naeem Shahid PhD KTH Stockholm

Li (Lily) Li (from March) PhD USyd

Administrator

Jeffrey Kealley

Australian Nanotechnology Network Manager

Elizabeth Micallef

Students

PhD

Huda Alkhaldi (from February)

Boshra Afra (till June)

Amira Ameruddin

Leonardus Bimo Bayu Aji

Thomas Bierschenk

Timothy Burgess

Keng Chan

Ruixing (Andy) Feng

Aruni Fonseka

Qian Gao

Hao Feng Lu

Nian (Jenny) Jiang

Mykhaylo Lysevych

Sahar Mirzaei

Pablo Mota Santiago (from September)

Parvathala Reddy Narangari (from April)

Miranda Nash

Kun Peng

Daniel Pyke (till December)

Dhruv Saxena

Daniel Schauries

Yuanjing Shen

Lachlan Smillie (from February)

Clara Teniswood

Thien Tuan Tran (from February)

Ian Yesaya Wenas

Xiaoming (Fred) Yuan

Bijun Zhao (from September)

MPhil

Sam Turner

Sarita Deshmukh

Sherman Wong

Prakash Prasai

Honours

Ryland Harris

Christian Henderson

Angus Heyworth

Zhi (Rex) Li

Beau Olsen

Wei Yang

Occupational Trainees

Felipe Kremer, PhD UFRGS (from August)

Yu-Jie Ma (from September)

Fenglin Xian (from September)

Guogang Zhang (from November)

Nurul Aini Tarjudin (from December)

Laser Physics Centre

Professor Wieslaw Krolikowski
Head of Department

Since its inception in 1987 the Laser Physics Centre (LPC) has been engaged in research areas that either utilize lasers or are motivated by laser-based applications. Under this umbrella we undertake a broad range of world-class research projects both fundamental and applied in nature. This research covers such areas as nonlinear optics, photonic device engineering, material science, quantum information, quantum sensing, solid-state spectroscopy, laser matter interaction and optical trapping. The underlying strength of the Centre is in how our people, working in these diverse but interrelated areas, continue to inform, motivate and enable each other's research.

The LPC hosts major programs from two Australian Research Council Centres of Excellence: The Centre for Ultrahigh Bandwidth Optical Systems (CUDOS) and The Centre for Quantum Computation and Communication Technology (CQC2T). These programs underpin central themes for the LPC: the development of integrated optical photonic devices for communication, sensing and quantum information applications.

During 2013 the Laser Physics Centre was engaged in numerous high profile research projects. Notable achievements included:

Demonstration of the first broadband mid infrared supercontinuum source spanning from 2-8 microns using a chalcogenide planar waveguide. The source is a vital component for a mid infra spectroscopic system for chemical finger printing. The keys to this success were the development of both low loss, dispersion engineered planar waveguides where we achieved the lowest losses over a very broad wavelength range of any material as well as a novel femtosecond mid-infrared optical parametric amplifier (OPA).

The first demonstration of the optical addressing of an individual erbium ion in silicon. In this work the optical excitation of a single erbium ion implanted in a silicon finFET transistor was detected electronically. This is the first step in developing a quantum interconnect between optical and silicon based quantum information devices. This work was conducted in collaboration with the University of New South Wales.

In December Prof. Wieslaw Krolikowski stepped down as head after a two-year appointment. We thank him for his valuable guidance and his contribution to the continued success of this department.

Academic Staff

Head of Department and Professor

Wieslaw Krolikowski (MSc PhD Warsaw)

Professors

Barry Luther-Davies (BSc, PhD (Southampton); FOSA; FTSE)

Neil Manson (PhD Aberdeen)

Andrei Rode (PhD Moscow)

Senior Fellows

Duk-Yong Choi (PhD Seoul)

Eugene Gamaly (MSc PhD DSc, Full Professor of Physics, Moscow)

Stephen Madden (PhD Imperial College)

Matthew Sellars (PhD)

Fellows

Rongping Wang (PhD CAS)

Research Fellows

Cyril Hnatovsky (PhD Ottawa)

Yan Sheng (PhD CAS, ARC Postdoctoral Fellow)

Vladlen Shvedov (PhD Taurida National)

Zhiyong Yang (PhD CAS)

Postdoctoral Fellows

Marcus Doherty (PhD, Bch Science (Honours), Bch Engineering (Honours))

Ludovic Rapp (PhD)

Khu Vu (PhD Mphil Southampton BSc (Honours) Monash)

Visiting Fellows

Deng Feng Chen

Anna Samoc

Marek Samoc

Wang Tong

Yang Xinyu

Professional Staff

Technical Officers

John Bottega

Sukhanta Debbarma

Maryla Krolikowska

Craig MacLeod

Research Officer

Robin Stevenson

Departmental Administrator

Sonia Padrun

Students

PhD Students

Rose Ahlefeldt

Michael Barson

John Bartholomew

Xin Chen

Niko Eckerskorn

Katherine Ferguson

Darren Freeman

Xin Gai

Ksawery Kajetan Kalinowski

Sara Marzban

Joseph Paulraj

Milos Rancic

Yue Sun

Ting Wang

Kunlun Yan

Yi (Ivy) Yu

Manjin (Grace) Zhong

Visiting Students

Jun Cheng

Katrin Kroeger

Li Li

Pan Ma

Yue Sun

Wenhou Wei

Si-Wei Xu

Other Students

Daniel Esposito

Sam Fischer

Prithvi Reddy

Richard Taylor

NONLINEAR PHYSICS CENTRE

Professor Yuri Kivshar
Head of Department

Nonlinear Physics Center is engaged in theoretical and experimental research in several areas of physics unified by the general concepts of nonlinear physics and photonics. Nonlinear Physics Center is composed of several major research groups with not sharply defined boundaries.

A majority of the experimental research in nonlinear photonics is led by Dr Dragomir Neshev who undertakes experimental studies of linear and nonlinear properties of light propagation and localization in photonic and nanoplasmonic structures including light self-action and harmonic generation, optical metamaterials, and nanophotonics. In 2013, the group's activities also included quantum optics in waveguide arrays, the physics of optical metamaterials, and all-dielectric nanostructures.

The theoretical group led by Dr Andrey Sukhorukov involves the development of theoretical models and numerical simulations of the propagation of slow light in nonlinear photonic structures, with close collaboration with the experimental groups. More recently, this included the development of novel concepts of light control in optomechanical systems as well as quantum walks in waveguide arrays.

The group in nonlinear matter-wave optics is led by Dr Elena Ostrovskaya, and it is involved in the development of novel theoretical models, analytical and numerical studies of matter waves and nonlinear atom-optics problems associated with Bose-Einstein condensates. Recent highlights of the group are the development of novel concepts and experimental demonstrations of polaritonic condensates.

The research on composite structures and left-handed metamaterials, led by Dr Ilya Shadrivov is in directions involving the phenomenon of negative refraction, nonlinear metamaterials and left-handed materials, and optical cloaking. Recently, the group developed novel concepts for tunable and reconfigurable metamaterials, and supported them by a series of experimental observations at microwave and THz frequencies.

The recently established group of Dr Andrey Miroshnichenko is focused on the study of the physics and applications of linear and nonlinear plasmonic structures and optical nanoantennas. The recent advances of this team include the prediction and demonstration of "magnetic light" effects in all-dielectric optical structures.

Academic Staff

Head of Department and Professor

Yuri Kivshar BSc PhD Kharkov, FAIP, FOSA, FAA, FAPS, FInstP

Senior Fellows

Dragomir Neshev PhD Sofia

Andrey Sukhorukov MSc Moscow, PhD

Fellows

Anton Desyatnikov Moscow PhD

Andrey Miroshnichenko PhD Dresden

Elena Ostrovskaya MSc Moscow, PhD

Willie Padilla San Diego, PhD (February to May)

Alexander Savin PhD Moscow (May to July)

Ilya Shadrivov PhD

Research Fellows

Robert Dall PhD

Manuel Decker PhD Karlsruhe

Yana Izdebskaya PhD Simferopol

Aliaksandr Minovich PhD

David Powell PhD RMIT

Isabelle Staude PhD Karlsruhe

Postdoctoral Fellows

Ivan Garanovich PhD (to April)

Christian Helgert PhD Jena (to March)

Ivan Maksymov PhD Kharkov (to August)

Lev Smirnov PhD Novgorod (September-November)

Alexander Solntsev PhD (from October)

Visiting Fellows

Prof Gaetano Assanto, University of Rome, Italy

Dr Maxim Dvornikov, University of San Paulo, Brazil

Dr Mikhail Lapin, University of Sydney

Professional Staff

Departmental Administrator

Kathy Hicks AdvDipAcct DipMngment CIT

Research Assistants

Andrei Komar (January)

Wei Liu (April-September)

Alexander Solntsev (May-October)

Students

PhD Students

Jasur Abdullaev

Diana Antonosyan

Katie Chong

Rui Guo

Kirsty Hannam

Ben Hopkins

Ali KH Mirzaei

Sergey Kruk

Daniel Leykam

Guangyao (Leo) Li

Mingkai Liu

Wei Liu

Alexander Solntsev

Yue Sun

Lei Wang

Che Wen (Allen) Wu

Yair Zarate

Honours Students

Ben Hopkins

Shuai Li

Visiting Students

Paul Ackerman, University of Colorado, USA

Alexander Atrashchenko, St Petersburg

Sebastian Brake, Westfälische Wilhelms-Universität Münster Institut für Angewandte Physik

Falko Diebel, Institute of Applied Physics, University of Muenster

NUCLEAR PHYSICS

Professor David Hinde
Head of Department

The Department of Nuclear Physics carries out fundamental research in Nuclear Physics, as well as developing and applying nuclear techniques for basic studies in interdisciplinary accelerator-based research. The Heavy Ion Accelerator Facility, maintained, developed and operated by the Department is supported financially by the ANU, and by CRIS and NCRIS operational funding from the Federal Government. It provides a wide range of energetic heavy-ion beams produced with a suite of ion sources and accelerated by a 15 million-Volt tandem electrostatic accelerator and a superconducting linear accelerator. Beams are delivered to ten separate beam-lines, each dedicated to specialized detector instrumentation.

The facilities are used by staff and students of the Department as well as external users from other Australian universities and institutions, and scientists from many overseas Universities and laboratories in Europe, North and South America and Asia. Scientists from the United Kingdom have formal access to the Facility through the ANU-STFC agreement.

The Department and its facilities constitute the main laboratory in Australia for accelerator-based research and training in Nuclear Physics. It contributes to undergraduate and postgraduate teaching and training at honours, masters and PhD levels, conducts expert workshops in radiation physics and accelerator techniques, and manages a Master of Nuclear Science by coursework degree that was instituted in 2007. To complement the research carried out on the local facilities, Department members collaborate with international scientists and utilize major experimental facilities overseas, gaining access through competitive processes.

Current nuclear research areas of interest cover nuclear spectroscopy and the study of exotic nuclear quantum states, heavy-ion reaction dynamics including nuclear fusion, nuclear fission and reactions of weakly-bound nuclei, and the study and use of hyperfine interactions for moment measurements and for elucidating nuclear structure. Nuclear techniques and heavy-ion detection techniques are used in a range of materials science applications including materials modification and characterization. The technique of Accelerator Mass Spectrometry is applied to a broad range of topics including research and applications in archaeology, hydrology, climate change, soil erosion and trace isotopic analyses applied to environmental pollution studies, both nuclear and non-nuclear. Recently, nuclear astrophysics became an additional major research topic at the Department.

Professor L. Keith Fifield retired at the end of 2013 after 27 years at the Department of Nuclear Physics. Keith obtained his PhD in Nuclear Physics from the University of Pennsylvania in 1973, and held research positions in nuclear physics laboratories at the universities of Pennsylvania and Oxford, and at the ANU. In 1986, he began to develop the new technique of accelerator mass spectrometry (AMS) at the ANU's 14UD Heavy-Ion Accelerator Facility. This became a full-time occupation from 1991. Since then, Keith has been at the forefront of innovation in both the methods and the applications of the technique. He has published more than 280 refereed papers in the fields of Nuclear Physics and AMS. He will continue his research in the Department as Professor Emeritus.

Academic Staff

Head of Department and Professor

David Hinde BSc Manchester, PhD, FAIP, FInstP, FAPS, FAA

Professor and Director, Heavy Ion Accelerator Facility

Keith Fifield MSc Auckland, PhD Penn, FAIP

Professors

Mahananda Dasgupta MSc Rajasthan, PhD Bombay, FAIP, FAA

Andrew Stuchbery BSc PhD Melbourne, FAIP

Emeritus Professor

George Dracoulis BSc PhD Melbourne, FAIP, FAPS, Hon FRSNZ, FAA

Senior Fellows

Tibor Kibédi PhD Debrecen

Gregory Lane BSc PhD (ARC Future Fellow)

Anton Wallner PhD Vienna

Fellows

Stephen Tims BSc PhD Melbourne

Dr Cedric Simenel (ARC Future Fellow)

Research Fellows

Mario DeCesare PhD Naples (until Oct)

Michaela Srncik PhD Vienna

Elizabeth Williams PhD Yale

Postdoctoral Fellows

Maurits Evers PhD (until June)

Duc Huy Luong PhD

Ramachandran Kandasamy PhD Mumbai

Sankha Hota PhD (from April)

Chandani Palshetkar PhD (from July)

Matthew Reed MPhys Leicester PhD Surrey

Visiting Fellows

Dr Tezer Esat, ANSTO

Dr Toshiyuki Fujioka, ANSTO (until Feb)

Dr Heiko Timmers, University of New South Wales/ ADFA

Dr Rickard Du Rietz MSc PhD Lund (until Feb)

Dr David Weisser, MSc, PhD Minn, FAIP (from June)

Professional Staff

Accelerator Research and Operations Managers

Nikolai Lobanov BSc Moscow, PhD St Petersburg

David Weisser MSc, PhD Minn, FAIP (Special Projects) (retired June)

Accelerator Engineer

Peter Linardakis PhD

Computer Manager Heavy Ion Facility

Dimitrios Tsifakis, BSc (Hons)

Embedded Systems Programmer

Nicholas Withers, BE (Hons), BIT (from June)

Scientific Programmer

Dr Toktam Ebadi PhD Otago (from July)

Technical Officers

John Bockwinkel, AdvDip MechEng CIT

Alan Cooper, Fitting and Machinist Trade Cert. AssDip MechEng CIT

Gareth Crook, Cert IV MechEng CIT

Caleb Gudu, AdvDip MechEng CIT

Gordon Foote BSc London, PhD

Allan Harding, Fitting and Machinist Trade Cert. (retired Dec)

Justin Heighway, AssDip AppSci CIT

Lorenzo Lariosa

Alistair Muirhead, Fitting and Machinist Trade Cert.

Thomas Tunningley AdvDip EngDesign CIT, B.Ind.Des. (Hon) UC

Aditya Wakhle PhD (from June)

Departmental Administrator

Petra Rickman

Students

PhD students

Badriah Alshahrani

Ian Carter

Kaitlin Cook

Michael Edwards

WeeTeck Hoo

Dongyun Jeung

Rajeev Lal

Boon Lee

Russell Leslie

Steven McNeil

Nyaladzi Palalani

Dominic Rafferty

Michael Smith

Aditya Wakhle PhD (until June)

Masters students (MPhil)

Asif Ahmed

Tristan Steele

Masters students (CWk)

Janette Deo

Glenn Broadhurst

Bret Grimshaw

Andrew Hall

Nigel Little

Bill Noble

Jarred Rorke

Katherine Schiffl

Maurice Walsh

Honours

Ellen Manning

Joseph Horst

Hannah Smith

Summer Scholars (ANU)

Melanie Hampel, University of Bonn, ANU Exchange

Matthew Talia, Monash University, ANU Exchange

Andrew Duong, Monash University, ANU Exchange

Visiting students

Aqeel Akber, 3rd year research project, ANU

Matthew Berrington, PhB, ANU

Martyn Dietze, 3rd year research project, Utrecht University, ANU Exchange

James Frith, 3rd year research project, ANU

Matthew Gerathy, 3rd year research project, ANU

Melissa Hogan, 3rd year research project, ANU

Kun Wang, Jzangnan University

PLASMA RESEARCH LABORATORIES SP3

Professor Christine Charles
Head of Department

The Space Plasma, Power and Propulsion division is lead by Prof Christine Charles and conducts work on both basic and applied plasma physics. The core research areas involve experimental, theoretical and computer simulation aspects of low pressure helicon discharges and high pressure (including atmospheric pressure) radiofrequency discharges and of their numerous applications.

Interaction of these plasmas with surfaces (etching, sputtering, deposition, surface functionalisation) are applied to microelectronics and optoelectronics processes, to focused ion beam sources, to fuel cell manufacturing for the hydrogen economy and to the design of materials with biological responses, catalytic activity, optical or mechanical properties. Formal collaborative development of industrial plasmas is proceeding successfully with LAM research of Silicon Valley.

Expansion of these plasmas is applied to electric propulsion with the development of three new thrusters (HDLT, Pocket Rocket, DS4G) and to space plasma physics such as the magnetic funnels of the solar corona and the Earth's aurora. Other research on space plasma physics includes studying high-beta plasmas, wave-plasma interactions, plasma instabilities, cross-field diffusion, momentum imparted from plasma expansion and plasma detachment from magnetic fields. We have developed a new national space simulation facility to test the thrusters in collaboration with the astronomers at Mount Stromlo and with various industry partners (EADS-Astrium, Lockheed Martin…).

Academic Staff

Head of Department and Professor

Christine Charles BEng MSc Rennes, PhD Hab Orléans, BMus

Professors

Roderick Boswell BSc Adelaide, PhD Flinders, FTSE, FAPS, FAA, AM

Visiting Fellows

Dr Craig Davis, Stayz Pty Ltd 2011

Dr James Dedrick

Dr Wesley Cox, Lam Research Corporation

Visitors

Mr Piotr Glowacki, DBD Innovations

Mr Guy Reynolds, DBD Innovation

Professional Staff

Technical Officers

Andrew Bish

Mike Petkovic (ASRP Project with RSAA)

Nick Herald (ASRP Project with RSAA)

Robert Boz (ASRP Project with RSAA)

Nicolas Paulin (ASRP Project with RSAA)

Departmental Administrator

Uyen Nguyen BA Monash

Students

PhD students

Sam Dixon

Amelia Greig

Yunchao Zhang

PLASMA RESEARCH LABORATORIES TORO

Professor John Howard
Head of Department

Toroidal Plasma Research embraces a diversity of activities associated with the physics of magnetised plasma, electromagnetics, fluids and remote sensing. The Department is home to the H-1 Australian Plasma Fusion Research Facility (APFRF), which is the national focus of high temperature experimental plasma fusion research for clean energy generation. It also houses a variety of smaller plasma devices and the experimental facilities of the physics of fluids group.

There are four primary research activities within the Department.

The Experimental Plasma Science group undertakes research into plasma magnetic confinement on the H-1 heliac, and fusion-relevant materials studies on the MAGnetised Plasma Interaction Experiment (MAGPIE) (which also involves formal collaborations with the Australian Nuclear Science and Technology Organisation). The techniques and instruments pioneered in the laboratory are deployed at many fusion institutes around the world.

The Plasma Theory and Modeling group focuses on the fundamental physics and modelling of magnetic confinement fusion energy devices. The group has flourishing research links with many international fusion laboratories around the world.

The Physics of Fluids group undertakes research into waves, turbulence and non linear phenomena, important for the physics of weather, climate, and plasma confinement.

The BushLAN project is developing the world's first fully distributed wireless telecommunications network. The distributed approach is inherently superior to, and potentially more economical than current universal cellular networks.

Academic Staff

Head of Department and Professor

John Howard BSc PhD Sydney, FInstP

Professors

Michael Shats MSc KPI, PhD GPI Moscow

Robert Dewar MSc Melbourne, PhD Princeton, FAIP, FAPS, FAA

Senior Fellows

Boyd Blackwell BSc PhD Sydney

Matthew Hole BSc BE PhD Sydney

Research Fellows

Cormac Corr PhD Belfast

Gerard Borg BSc PhD Sydney

Hua Xia MSc Chongquing PhD

Clive Michael Bsc PhD

Postdoctoral Fellows

Graham Dennis PhD

Gregory von Nessi BSc Massachusetts PhD

Michael Fitzgerald PhD University of Sydney (finished 10/2013)

Nicolas Francois BEng Toulouse PhD Université Bordeaux 1

Visiting Fellows

Dr Jay Larson, Argonne National Laboratory, USA

Visitors

John Wach BAppSci CAE Ball GradDipEl CCAE

Professional Staff

Technical Officers

Bernhard Seiwald PhD Graz Uni. of Tech (until Nov 2013)

David Pretty BSc Melb PhD (until November 2013)

Fenton Glass BSc Queensland PhD

Horst Punzmann BSc Regensburg PhD

Mark Gwynneth

Michael Blacksell BEngineering University of Canberra

Departmental Administrator

Uyen Nguyen BA Monash

Quantum Science

Professor David McClelland
Head of Department

The core research programs in the Department of Quantum Science cover a broad range of activities linked by the quest to investigate the interface between the quantum and classical realms, to probe the quantum mechanical limits to measurement, to develop precision measurement using quantum sources, and to use these concepts in technological applications. These activities are pursued in three programs.

Quantum Optics: The quantum optics group aims to exploit quantum mechanical properties of laser fields for metrological and information technology applications. As the second largest node of the Centre of Excellence for Quantum Computation and Communication Technology, it hosts programs in Secure Quantum Communication, Quantum Memory and Quantum Repeater. In addition to the Centre programs, the group also undertakes research in quantum opto-mechanics and ultra-precision machining. Major results achieved in 2013 include: Storage of light in super dense atomic ensembles (published in New Journal of Physics), proposing a scheme for using laser light to levitate a macroscopic mirror suitable for metrological applications (published in Physical Review Letters).

Atom Optics: The atom optics program has focused on the development of the atom laser as a useful tool for investigations in fundamental physics and in precision inertial measurement. All cold atom precision inertial measurements have used cold thermal atomic sources, and all are limited in their precision by classical or technical noise sources. Can the high brightness and long coherence length of atom lasers mitigate these limiting effects? This is the question that, in part, drives our research program. At the applied end of the research spectrum, we are exploiting our technology in the development of field deployable inertial sensors in close collaboration with end users. In 2013, we continued to develop a next generation gravitational sensor with a projected sensitivity that promises to provide the best local measurement of gravity in the world. The apparatus spans two stories in the Department and required modification to the building to allow installation. In addition, we developed the first solitonic atom interferometer and demonstrated enhanced fringe visibility and signal to noise ratio in an interferometric measurement (published in Physical Review Letters).

The Centre for Gravitational Physics undertakes research on many aspects of gravity, from mathematical relativity to searching for gravitational waves to developing technology for future generations of ground and space based gravitational wave detectors, earth observations and sensing. Highlights in 2013 included: using quantum enhancement to deliver the most sensitive gravitational wave detector ever built (published Nature Photonics); and searching for gravitational waves from binary black hole inspirals. We continued our collaboration with the National Measurement Institute to develop optical sensors for drug testing and our program to revolutionise and commenced a new collaboration with Electro Optic Systems to developed CW laser ranging for tracking space debris

Academic Staff

Head of Department and Professor

David McClelland BSc (Hons1) MSc PhD (Otago) FAPS FOSA FASA FAIP

Professors

John Close BSc, MA Berkeley, PhD Berkeley, SFHEA

Ping Koy Lam BSc Auckland, PhD

Craig Savage BSc MSc DPhil (Waikato), SFHEA

Susan Scott BSc (Hons) Monash, PhD Adelaide, EURASC, FAIP, FInstP

Daniel Shaddock PhD

Emeritus Professors

Hans-A Bachor Diplom Physiker Hannover, PhD Hannover AM, FAA, FAIP, FIOP, FOSA

John Love, MA DPhil DSc Oxford, MA MMath Cambridge

Ronald John Sandeman OAM, BSc Adel, MSc Melb, PhD Cantab, FAIP

Senior Fellows

Joseph Hope PhD

Fellows

Benjamin Buchler PhD

Jong Chow BSEE Vermont, PhD ANU

Nicholas Robins PhD

Thomas Symul PhD CNET

Research Fellows

Andre de Carvalho PhD UFRJ Brazil

Jiri Janousek PhD DTU Denmark

Mattias Johnsson PhD Canterbury

Bram Slagmolen PhD

Robert Ward PhD Caltech

Postdoctoral Fellows

Syed Assad PhD NUS Singapore/ANU

Julien Bernu PhD ENS France

David Bowman PhD ADFA

Sheon Chua PhD (from 12 April)

John Debs PhD

Roland Fledderman PhD LUH Germany

Mahdi Hosseini PhD

Noschang Kuhn, Carlos Claiton PhD UFRGS (Brazil) (from 1 March)

Timothy Lam PhD (from 20 June)

John Miller PhD Glasgow (until 19 March)

Olivier Pinel PhD Paris

Alberto Stochino PhD Caltech (until 1 April)

Andrew Sutton PhD (from 4 March)

Visiting Fellows

Dr Mark Andrews

Dr Quentin Glorieux

Dr Peter Riggs

Professional Staff

Head Technical Officer

Andrew Papworth

Technical Officers

Neil Devlin

James Dickson (until 26 October)

Shane Grieves

Neil Hinchey

Paul McNamara

Paul Tant

Departmental Administrator

Laura Walmsley

Assistant Administrative Officer

Gaye Carney

Centre of Excellence for Quantum Computation and Communication Technology

Node Administrator

Amanda White

GRACE FoM Project Administrator

Kerrie Cook (until 30 June)

Students

PhD Students

Sarah Adlong
Seiji Armstrong
Richard Barry
Shayne Bennetts
Christopher Bentley
Alexandre Brieussel
Geoff Campbell
Helen Chrzanowski
Sheon Chua
Jarrod Dong
Giovanni Guccione
Jesse Everett
Sam Francis
Kyle Hardman
Jing Yan Haw
Sara Hosseini
Jessica Hudspeth
Timothy Lam
Benjamin Lewis
Georgia Mansell
Gordon McDonald
Ruth Mills
Adam Mullavey
Silvie Ngo
Thanh Nguyen
Steven Pederson
Tarquin Ralph
Shasidran Raj
Nicolas Riesen
Lyle Roberts
Harry Slatyer
Benjamin Sparkes
Andrew Sutton
Philip Threlfall
Andrew Wade
Paul Wigley
Ross Whitfield
Danielle Wuchenich

Masters Students (Coursework)

Jesse Boylan
Glenn Broadhurst
Janette Deo
Bret Grimshaw
Andrew Hall
Nigel Little
Zahra Mirmoeini
Bill Noble
Robert Parker
Jarred Rorke
Farhad Safazadeh
Katherine Schiffl
Nicholas Vazenios
Jie Wang

Summer Scholars

Chaimanowong Wee
Daniel Comber-Todd

Occupational Trainees

Jiao Geng

Honours Students

Ethan Barden
Jake Glidden

Theoretical Physics

Professor Murray Batchelor
Head of Department (until April)

Professor Vladimir Bazhanov
Head of Department (from April)

The Department of Theoretical Physics is one of the university's founding departments. The primary research themes in the Department are in mathematical physics and optical sciences.

The work in mathematical physics is in a number of related areas in statistical mechanics, quantum field theory and string theory. Professor Vladimir Bazhanov, Dr Vladimir Mangazeev and Dr Zengo Tsuboi lead research in (i) algebraic approaches to lattice systems (ii) integrability structure of quantum field theory, (iii) quantum groups and three-dimensional integrable systems. Dr Xiwen Guan leads research on exactly solved (integrable) models in cold atoms and spin systems.

Professor Murray Batchelor leads research on aspects of exactly solved models in statistical mechanics, most recently on understanding the implications of the remarkable connection between the theory of Yang-Baxter integrability and the notion of discrete holomorphicity. Professor Peter Bouwknegt leads research on the mathematics of string theory and quantum field theory. Dr David Ridout leads research on the mathematical structures underlying conformal field theory, with the properties of logarithmic conformal field theories of particular interest. Work on fundamental aspects of condensed matter is led by Professor Makunda Das, in particular on high temperature superconductivity and vortex matter phase transitions and electron transport in mesoscopic systems.

The Optical Sciences Group led by Professor Nail Akhmediev and Dr Adrian Ankiewicz performs studies in extreme events, rogue waves and soliton theory. The group develops basic theory of dissipative solitons that includes high-power ultra-short pulse lasers and giant waves in the ocean. The group is strongly linked to international research laboratories working at the forefront of ocean waves, nonlinear optics and dissipative systems.

In 2013 Emeritus Professor Rodney Baxter who is the founder of mathematical physics research at the ANU has been awarded a Royal Medal for “remarkable exact solutions of fundamental models in statistical mechanics”. The Royal Medal, also known as The Queen's Medal, awarded each year by the Royal Society, two for "the most important contributions to the advancement of natural knowledge" and one for "distinguished contributions in the applied sciences" made within the Commonwealth of Nations. Some of the previous winners include many of the greats from the Natural Sciences over the past 150 years – to name just a few: John Dalton, Michael Faraday, James Joule, Charles Darwin, J.J. Thompson, Paul Dirac, Lawrence Bragg.

Academic Staff

Head of Department and Professor

Murray Batchelor BSc (Hons) UNSW, PhD, FAIP, FAustMS, FInstP (jointly with MSI) (until April)

Professors

Nail Akhmediev MS PhD DSc Moscow, FOSA

Peter Bouwknegt MSc Utrecht, PhD Amsterdam, FAIP, FAustMS (Deputy Director of MSI)

Emeritus Professors

Brian Robson MSc PhD DSc Melb, FAIP

Lindsay Tassie MSc PhD Melb, FAIP

Mukunda Das BSc PhD Roorkee University

Research Fellows

Adrian Ankiewicz BSc BE UNSW, PhD

Wonkeun Chang BTech (Hons), MSc, PhD ANU (ARC Fellowship)

Vladimir Mangazeev MSc Moscow, PhD Serpukhov

David Ridout BSc, MSc UWA, PhD Adelaide (ARC Fellowship)

Zengo Tsuboi MSc PhD Tokyo

Xi-Wen Guan BSc Qufu, MSc Sichuan, PhD Jilin

Postdoctoral Fellows

Natasha Devine PhD

Visiting Fellows

Angela Foerster PhD FU-Berlin

Chaoqing Dai PhD Suzhou University

Sergey Sergeev MSc PhD Steklov Institute of Mathematics

Simon Wood PhD from ETH Zurich (Switzerland)

Yusuke Kageyama PhD Kyushu Univeristy

Yvan Saint-Aubin PhD from U de Montreal (Canada)

Professional Staff

Departmental Administrator

Lucia Lu

Students

PhD

Amdadul H Chowdury

Andrew Kels

Brendan Wilson

Callan Cain

David Kedziora

Kyle Wright

Imam Alam

Song Cheng

Victor Surkus

MPhil

Seong Joon Yi