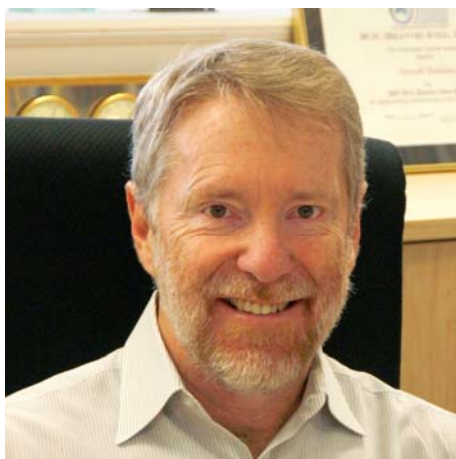


RESEARCH



*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 over 150 academics, 110 general staff and 130 post graduate students.

The School's research thrusts in selected areas of strength cover the entire spectrum from fundamental research (understanding nature) 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 School continued to excel in its research performance, with 420 journal publications in 2011 and its 138 international conference papers. Physics at ANU achieved the highest rank in in the Excellence for Research in Australia ranking (ERA level 5). In 2011 the School was successful in winning over \$31 million in research grants of which \$14 million was from the Australian Research Council.

The link between research and teaching is critical to the future of the School and the nation. The School has made a major commitment in using its research strength and scale, together with its unique mix of outstanding researchers, teachers and infrastructure, to developing world-leading education programs for gifted students that link directly to postgraduate research study. The research and teaching links are not only confined to the Physics discipline but have significant involvement with Engineering and with other science disciplines.

RSPE is comprised of nine 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.

Applied Mathematics

Atomic & Molecular Physics Laboratories

Electronic Materials Engineering

Laser Physics

Nonlinear Physics

Nuclear Physics

Plasma Research Laboratory

Quantum Science

Theoretical Physics

Professor Ken Baldwin is also Director of the Australian Centre of Excellence for Quantum-Atom Optics, Director of the ANU Energy Change Institute and Professor in the Atomic and Molecular Physics Laboratories.

APPLIED MATHEMATICS



*Professor Vince Craig
Head of Department*

There are two kinds of truth: the truth that lights the way and the truth that warms the heart. The first of these is science, and the second is art. Neither is independent of the other or more important than the other. Without art science would be as useless as a pair of high forceps in the hands of a plumber. Without science art would become a crude mess of folklore and emotional quackery. The truth of art keeps science from becoming inhuman, and the truth of science keeps art from becoming ridiculous. -Raymond Thornton Chandler, writer (1888-1959)

Condensed matter and materials research dominates the research performed in the Department but we are notoriously difficult to pigeon-hole as the range of research programs currently underway are numerous and diverse; for example, statistical mechanical studies of liquids at interfaces, specific ion effects in soft matter, modeling and experiments of multiphase flow properties of oil-bearing rocks, tomographic imaging of fossils, nanobubbles for cleaning, low dimensional geometry and topology as structure descriptors and studies of networks and are part of the group's ongoing research programs. We also host artists in residence and a seminar program that extends from applied mathematics to investigations of European interaction with the east coast of Australia prior to Captain Cook and the foods of the aboriginals on the south coast in the 1700s. This large portfolio of research is possible, due to our strong network of collaborators around the world and the contribution of individuals in the Department to areas outside of their core areas of interest.

The burgeoning success of the Departments spin-off company, Digital Core, now provides us with the opportunity to embrace new challenges, particularly in the area of tomography and tomographic data analysis applied to new problems. A large international consortium of oil and gas companies continues to financially underpin our research effort, particularly in the CT and wetting areas.

Members of the Department continue to embrace new challenges, including seeking out new funding to address the ever diminishing block grant and participating in a wide variety of teaching and supervision roles in Physics, Engineering and Chemistry.

The challenge we face in the coming years is to continue to find new sources of funding whilst remaining at the cutting edge of fundamental research and finding time to think. Through our science we continue to seek truth and beauty.

The best people possess a feeling for beauty, the courage to take risks, the discipline to tell the truth, the capacity for sacrifice. Ironically, their virtues make them vulnerable; they are often wounded, sometimes destroyed. -Ernest Hemingway, author and journalist, Nobel laureate (1899-1961)

Academic Staff

Head of Department

Vince Craig BSc PhD, ARC Future Fellow

Professors

Stephen Hyde BSc PhD Monash, ARC Federation Fellow

Mark Knackstedt BSc Columbia, PhD Rice

Tim Senden BSc PhD

David Williams BSc Sydney, PhD Cambridge

Senior Fellows

Vince Craig BSc PhD, ARC Future Fellow

Adrian Sheppard BSc Adelaide, PhD

Research Fellows

Lilliana De Campo BSc PhD Graz

Andrew Fogden BSc PhD Docent Lund

David King BSc

Shannon Notley BSc PhD

Drew Parsons PhD

Vanessa Robins BSc, PhD Colorado

Ross Stephens PhD Sydney

Arthur Sakellariou BSc PhD Melbourne (until February)

Rob Sok BSc PhD Groningen

Trond Varslot MSc PhD NTNU

Postdoctoral Fellows

Nicolas Francois PhD Bordeaux

Andrew Kingston PhD Monash

Shane Latham BSc PhD UQ

Mayhar Madadi BSc Tehran, MSc PhD IASBS

Glenn Myers PhD Monash

Mohammad Saadatfar PhD

Michael Turner, PhD

Visiting Fellows

Dr Christoph Arns, University of NSW

Dr Ji-Youn Arns, University of NSW (until July)

Dr Tomaso Aste, University of Kent

Dr Judith Caton

Dr Robert Corkery, Lund University

Mr Arthur Davies

Dr Tiziana Di Matteo, King's College (until February)

Prof Phil Evans, University of British Columbia (from May)

Ms Denise Higgins (until October)

Prof John Maloney (from May)

Prof Stjepan Marcelja, University of Rochester

Prof Yoshinori Nagi, University of Kokushikan

Prof Norman Morrow, University of Wyoming

Prof Barry Ninham

Mr Jafar Qajar, University of NSW (until July)

General Staff

Senior Software Designer

Paul Veldkamp BSc BEc

Technical Officers

Holger Averdunk

Anthony Hyde AssocIE

Rohini Marathe, BSc Mumbai, MSc Rutgers (from September)

Tim Sawkins

Departmental Administrator

Margo Davies DipDent Tasmania

ATOMIC & MOLECULAR PHYSICS



*Professor Stephen Buckman
Head of Department*

The Atomic and Molecular Physics Laboratories are engaged in a broad range of experimental, theoretical and computational studies of the interaction of electrons, positrons, and photons with atoms, molecules and solids. Our goal is both to further our knowledge of fundamental physical and chemical processes, and to provide essential information that is critical to applications in other scientific disciplines, technology, and the environment.

The Laboratories' research activities include Photon interactions: VUV/XUV laser spectroscopy, laser photodetachment and photofragment spectroscopy, computational molecular physics, computational planetary atmospheres, computational multiple photo ionization); Positron and electron interactions: low-energy positron and electron physics, materials studies with positrons, Electron Momentum Spectroscopy studies of gases and solids, 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.

The Laboratories also host an Australian Research Council Centre of Excellence: the Australian Research Council Centre of Excellence for Antimatter-Matter Studies (CAMS), whose experimental and theoretical program is based on the study of the interaction of positrons and electrons with matter. The year also saw the final phase of the Australian Research Council Centre of Excellence for Quantum-Atom Optics (ACQAO) which had been in operation for the past 8 years.

Academic Staff

Head of Department

Stephen Buckman BSc PhD Flinders, FAPS, FAIP, FInstP

Professors

Kenneth Baldwin MSc, DIC PhD London, FAIP, FInstP, FOSA, FAPS

Anatoli Kheifets BSc PhD St Petersburg, FAPS

Brenton Lewis PhD DSc Adelaide, C Phys, FInstP, FAPS, FOSA, FAIP (until June)

Senior Fellows

Stephen Gibson BSc PhD Adelaide

Maarten Vos MSc PhD Gröningen

Fellows

Franklin Mills BSE Princeton, MS PhD Caltech

James Sullivan BSc PhD

Andrew Truscott BSc PhD Queensland

Research Fellows

Steven Cavanagh BSc PhD Griffith

Robert Dall BSc Queensland PhD

Mitsuhiko Kono MSc KyotoIT, PhD GUAS Tokyo (from June)

Igor Ivanov PhD DSc Moscow

Postdoctoral Fellows

Casten Makochekeka BSc Zimbabwe, MSc PhD Yamaguchi (until August)

Eskender Mume BSc PhD Uppsala (ANSTO)

Selvakumar Sellaiyan BSc PhD (ANSTO)

Postdoctoral Research Assistant

Jessica Brunton BSc (Hons) Flinders, PhD Flinders

Visiting Fellows

Prof Lewis Chadderton

Em Prof Robert Crompton AM

Dr Mitsuhiko Kono (from Feb)

Prof Robert McEachran

Prof Dennis Mueller (University of North Texas)

Dr Christopher Parkinson (University of Michigan)

Adjunct Prof Robert Robson (James Cook University)

Dr Brad Sandor (Space Science Institute)

Em Prof Erich Weigold AM

Dr Valerie Wilquet (Belgian Institute for Space Aeronomy)

General Staff

Technical Officers

Stephen Battison AssocDip MechEng CIT

Colin Dedman AssocDip Scilnst Bendigo CAE

Ross Tranter

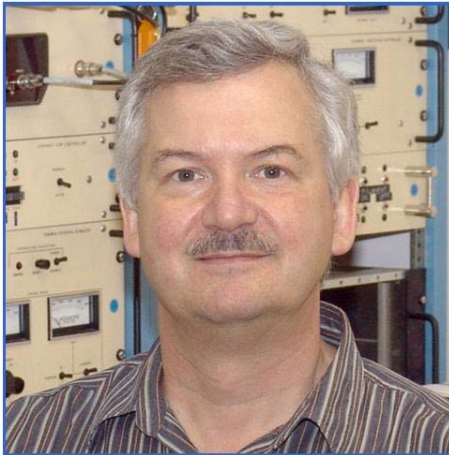
CAMS Chief Operating Officer

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

Departmental Administrator

Julia Wee BA Sydney, GCM MGSM

ELECTRONIC MATERIALS ENGINEERING



*Professor Robert Elliman
Head of Department*



*Professor Mark Ridgway
Acting 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 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.

2011 was a stellar year for the Department. Research quality continued to be outstanding and our success with external funding applications was exceptional. The year also saw EME academic staff rejuvenated with the appointment of three mid-career researchers, Drs. Jodie Bradby, Patrick Kluth and Lan Fu, to tenured positions. A change of leadership also followed with Prof. Rob Elliman completing his final term as Head of Department. His wise fiscal management policy steered the Department through difficult times and I thank Rob for his dedicated service over the last 11 years.

Academic Staff

Head of Department

Robert Elliman BAppSci, MAppSci RMIT, PhD DSc Salford, FAIP, FIP (until August)

Mark Ridgway BSc McM, MSc PhD Queens (Acting HOD from May and HOD from August)

Distinguished Professors

Chennupati Jagadish MSc PhD Delhi, FAA, FTSE, FAIP, FInstP, FloN, FIEEE, FAPS, FOSA, FSPIE,

FECS, FIET, FAAAS, FAVS, FECS

Australian Laureate Fellow

Professors

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

Senior Fellows

Hoe Tan BE Melbourne, PhD

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

Fellows

Jodie Bradby BAppSc RMIT, PhD

Lan Fu MSc UTSC, PhD

Patrick Kluth DipPhys Düsseldorf, PhD Jülich

Jiandong Ye PhD Nanjing

Sudha Mokkapatil PhD (from July)

Research Fellows

Leandro Araujo MSc PhD UFRGS (till February)

Qiang Gao MS BSc, NEU PhD

Wen Lei MSc CUG, PhD CAS

Postdoctoral Fellows

Satyam Bhuyan PhD Iowa State (until July)

Supakit Charnvanichborikarn PhD (until May)

Bianca Haberl PhD

Tae Hyun Kim PhD

Patrick Parkinson MPhys DPhil Oxon

Matias Rodriguez PhD

Avi Shalav MSc DipTchg Massey, PhD UNSW

David Sprouster PhD

Dinesh Venkatachalam PhD RMIT MSc BITS

Hao Wang MSc Jinan, PhD South China Normal

Steffen Breuer PhD (from October)

Raquel Giulian PhD (until February)

Pawel Sajewicz, MSc Warsaw University of Technology, PhD UCC Tyndall (from August)

Hazar Salama, PhD UNSW (from March)

Felipe Kremer, PhD UFRGS (from August)

Ian McKerracher PhD (from December)

Visiting Fellows

Ping Ping Chen, SITP (until August)

Marvin Cohen, UC Berkley (October)

Stefan Decoster, KUL (until October)

Neville Fletcher, AM, PhD, FAA, FTSE, Flnt P, FAIP, FAAS, FASA

Haroldo Hattori, ADFA

Mladen Petravic, University of Rijeka, Croatia

Simon Ruffell Varian

General Staff

ANFF Manager

Fouad Karouta BSc LUB, PhD Perpignan, PhD Montpellier

ANFF Processing Engineers

Animesh Basak PhD KUL (joint with AMMRF)

Xijun Li PhD CAEP (until November)

Jie Tian PhD CAEP

Kaushal Vora PhD Latrobe

ANFF Administrator

Jeffrey Kealley

Research Assistants

Kidane Belay MSc AAU Ethiopia, PhD

Gregory Jolley PhD

David Llewellyn (joint CMBE)

Technical Officers

Michael Aggett AssocDipMechEng CIT

Dane Kelly

Bernie King ONC London

Craig Saint (until April)

Thomas Kitchen AdvDipMechEng (from November)

Australian Nanotechnology Network Manager

Elizabeth Micallef

Departmental Administrator

Scott Yates

LASER PHYSICS CENTRE



*Professor Barry Luther-Davies
Head of Department*

During 2011 the Laser Physics Centre was engaged in numerous high profile research projects of fundamental as well as applied nature covering such areas as nonlinear optics, material science, quantum computing, solid state spectroscopy, laser matter interaction and optical trapping.

Research highlights for 2011 have included:

Optical devices

- ◆ Demonstration of on-chip stimulated Brillouin scattering and slow light in chalcogenide waveguides (with U. Sydney)
- ◆ Fabrication of ultra-high-Q 2-D microcavities with intrinsic $Q \geq 750,000$ in chalcogenide 2-D photonic crystal fully embedded in a silica cladding
- ◆ Design of ultra-low dispersion chalcogenide waveguides for correlated photon generation free from Raman noise

Optical materials and nonlinear optics

- ◆ Development of the fabrication process of silver doped chalcogenide glass waveguides, and measured very high nonlinearity (~ 1000 times higher than that of silica).
- ◆ Analytical theory of formation of spatial solitons and their interaction in nonlocal media with competing focusing and defocusing nonlinearities (with Tech. Univ. Denmark)
- ◆ Experimental demonstration of the broadband second harmonic generation in randomized nonlinear photonic crystals (Chinese Acad. Sci., Beijing; U. Mainz, Max Planck Inst. Polymer Res.).
- ◆ Observation of Cerenkov third-harmonic generation in quadratic nonlinear photonic crystal (with U. Polit. Catalunya, Tel Aviv U., Nankai U.)

Laser matter interaction

- ◆ First experimental demonstration of theoretically predicted but never observed before super-dense aluminium in laser-induced micro-explosion confined inside sapphire crystal by international team including our colleagues E.G. Gamaly and A.V. Rode.
- ◆ The book by Eugene Gamaly *Femtosecond Laser-Matter Interaction: Theory, Experiments and Applications*, (CRC Press, Taylor & Francis; Pan Stanford Publishing 2011).
- ◆ Demonstration of the effect of polarization on ablation and pattern formation in media illuminated by tightly focused femtosecond vector beams.

Quantum computing and solid state spectroscopy

- ◆ Observation and characterization of the electric dipole-dipole interactions between europium ions in $\text{Lu}^{3+}:\text{EuCl}_3 \cdot 6\text{D}_2\text{O}$ crystals.
- ◆ The order of the electronic states of the nitrogen vacancy centre has been established, resolving a controversy in the literature (with U. Melbourne, Queens U. Belfast)

Laser trapping

- First ever demonstration of micron-sized light-absorbing particles trapping and transportation in air in three dimensions with a single laser beam.
- Theory and experiments on using polarization of the laser vortex beam to control photophoretic trapping and transport of particles in air.

In December Prof. Barry Luther-Davies stepped down as head. Barry has led the LPC continuously from its inception in 1987. We thank him for his contribution to the success of this department.

Academic Staff

Professor and Head of Department

Barry Luther-Davies PhD St'ou, SIEE, FAIP, ARCF

Yan Sheng PhD Institute of Physics, Chinese Academy of Science, Beijing

Professors

Wieslaw Krolikowski MSc PhD DSc Warsaw, FOSA

Andrei Rode PhD Moscow

Neil Manson PhD Aberdeen

Visiting Fellows

Dr Anna Samoc

Prof. Marek Samoc, Wroclaw University of Technology, Poland

Dr Ludovic Rapp, University of Mediterranean Aix-Marseille II, France

Prof. Ole Bang, Technical University of Denmark

Prof. Echart Foerster, Jena University, Germany

Dr Igor Malkiel, Hermitage, St Petersburg, Russia

Prof. William Randall Babbitt, Montana State University, USA

Senior Fellows

Eugene Gamaly PhD DSc Moscow

Matthew Sellars PhD ANU

Fellows

Duk Yong Choi PhD Seoul

Rongping Wang PhD Chinese Academy of Science, Beijing

Steve Madden PhD Imperial College

General Staff

Research Fellows

Cyril Hnatovsky PhD Ottawa

Vladlen Shvedov PhD Taurida National V.I. Vernadsky University, Ukraine

Zhiyong Yang PhD Chinese Academy of Sciences, Beijing

Technical Officers

John Bottega

Sukanta Debbarma

Romana Krolikowska

Craig Macleod Assoc Dip MechEng CIT

Anita Smith BSc Flinders

Postdoctoral Fellows

Morgan Hedges PhD ANU

Sven Wittig PhD University of New South Wales

Departmental Administrator

Sonia Padrun (from April)

NONLINEAR PHYSICS CENTRE



*Professor Yuri Kivshar
Head of Department*

Nonlinear Physics are engaged in theoretical and experimental interdisciplinary research in a number of diverse areas unified by the general concepts of nonlinear physics and nonlinear photonics. Nonlinear Physics are defined by six major research directions and groups.

The experimental photonics group, led by Dr Dragomir Neshev, undertakes experimental study of linear and nonlinear properties of light propagation and localization in integrated and optically-induced photonic structures including waveguide arrays, photonic lattices, photonic crystals, as well as polychromatic light, nonlinear patterns and self-focusing. In 2011, the group's activities moved towards quantum optics in waveguides, nanophotonics, and the physics of optical metamaterials.

The theoretical photonics group, led by Dr Andrey Sukhorukov undertakes the study of different linear and nonlinear optical systems. Currently, this 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 periodically modulated waveguide arrays and optomechanics, as well as quantum effects on waveguide arrays.

The singular photonics group, led by Dr Anton Desyatnikov undertakes both theoretical and experimental studies of the light beams with angular momentum, optical vortices, optical polarization singularities, and vortex lattices. The new activities in 2011 are associated with the physics of knots and complex phases of light.

The nonlinear matter waves and quantum-atom optics group, led by Dr Elena Ostrovskaya, is involved in the development of novel theoretical models, analytical and numerical studies of matter waves and nonlinear atom-optics problems, cold atoms, Bose-Einstein condensates in optical lattices and magnetic waveguides, atom laser, quantum optics of nonclassical and squeezed light. More recently, the group developed several novel concepts, including the study of solitons and vortices in polariton 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 superlattices, optical cloaking and transformation optics. Recently, the group developed novel concepts for tuneable and reconfigurable metamaterials, and supported them by a series of experimental observations.

More recent developments of the NLPC research activities and the success of Dr Andrey Miroshnichenko with the Future Fellowship grant led to the creation of the sixth research group focused on the study of the physics and applications of linear and nonlinear plasmonic structures and optical nanoantennas.

Academic Staff

Professor and Head of Department

Yuri Kivshar BSc PhD Kharkov, FAIP, FOSA, FAA,
FAPS, FlntP, ARC Federation Fellow

Senior Fellows

Dragmoir Neshev PhD Sofia

Fellows

Anton Desyatnikov PhD Moscow

Elena Ostrovskaya MSc Moscow, PhD ANU

Alexander Savin PhD Moscow (January-February
and September-December)

Ilya Shadrivov PhD ANU

Andrey Sukhorukov MSc Moscow, PhD ANU

Research Fellows

Manuel Decker PhD Karlsruhe (from August)

Mikhail Lapine PhD Osnabruck (to August)

Aliaksandr Minovich PhD

Andrey Miroshnichenko PhD Dresden

David Powell PhD Monash

Zhiyong Xu PhD Barcelona

Postdoctoral Fellows

Ivan Garanovich PhD

Christian Helgert PhD Jena (from December)

Yana Izdebskaya PhD Simferopol

Ivan Maksymov PhD Kharkov

Michal Matuszewski PhD Warsaw (to March)

Isabelle Staude PhD Karlsruhe (from August)

Thomas White PhD (jointly with Laser Physics)

Weiren Zhu PhD Xian (from May)

Visiting Fellows

Dr Pusheng Liu, UEST China

Prof Roland Schiek, Regensburg, Germany

Dr Guangyong Zhang, China

Research Assistant

Artur Davoyan PhD (to May)

General Staff

Departmental Administrator

Kathy Hicks AdvDipAcct CIT

NUCLEAR PHYSICS



*Professor David Hinde
Head of Department*



*Professor Andrew Stuchbery
Acting Head of Department*

The Department of Nuclear Physics carries out fundamental studies in experimental Nuclear Physics as well as developing and applying nuclear techniques for basic studies in interdisciplinary research, much of it accelerator-based. The Heavy Ion Accelerator Facility, maintained, developed and operated by the Department, provides a 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 specialised 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 international scientists from a number of laboratories. Scientists from the United Kingdom, for example, have formal access to the facilities 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 utilise 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 and 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 characterisation. 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.

Academic Staff

Professors and Head of Department

David Hinde BSc Manchester, PhD, FAIP, FInstP,
FAPS FAA (until July)

Andrew Stuchbery BSc PhD Melbourne, FAIP (July
- December)

Professor and Director of Heavy Ion Accelerator Facility

Keith Fifield MSc Auckland, PhD Penn, FAIP

Professors

Aidan Byrne MSc Auck, PhD, FAIP

Mahananda Dasgupta MSc Rajasthan, PhD
Bombay, FAIP, FAA

Emeritus Professors

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

Senior Fellows

Tibor Kibédi PhD Debrecen

Gregory Lane BSc PhD (ARC Future Fellow from
May)

Anton Wallner PhD Vienna (from October)

Fellows

Stephen Tims BSc PhD Melbourne

Research Fellows

Rickard du Rietz MSc PhD Lund

Cédric Simenel MSc Paris PhD Caen (until April)

Postdoctoral Fellows

Maurits Evers PhD

Michael Smith

Visiting Fellows

Dr Tezer Esat, ANSTO

Dr Toshi Fujioka, ANSTO

Dr Heiko Timmers, University of New South Wales/
ADFA

Dr Cedric Simenel, CEA/Saclay, France (from
April)

General Staff

Accelerator Research and Operations Managers

Nikolai Lobanov BSc Moscow, PhD St Petersburg

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

Computer Manager Heavy Ion Facility

Dimitrios Tsifakis, BSc (Hon)

Computer Control Specialist

Angus Gratton, BSc, BAS

Technical Officers

John Bockwinkel, AdvDip MechEng CIT

Alan Cooper, AssDip MechEng CIT

Gareth Crook, Cert IV MechEng CIT

Caleb Gudu, AdvDip MechEng CIT (from February)

Gordon Foote BSc Lond, PhD (Casual)

Allan Harding

Justin Heighway, AssDip AppSci CIT

Tom Kitchen, AdvDip MechEng CIT (until November)

Lorenzo Lariosa

Peter Linardakis PhD (Accelerator Engineer) (from
December)

Alistair Muirhead

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

Departmental Administrator

Petra Rickman

PLASMA RESEARCH LABORATORIES



*Professor John Howard
Head of Department PRL
TORO*



*Professor Christine Charles
Head of Department PRL:
Space Plasma, Power and
Propulsion (SP3)*

Plasma Research Laboratory conducts research in two main areas: toroidal and space plasma.

Toroidal Plasma research embraces a multiplicity of activities associated with the physics of magnetised plasma, electromagnetics, fluids, remote sensing and inverse methods. The Department operates the Australian Plasma Fusion Research Facility which is centred on the H-1 heliac, an innovative plasma confinement device with flexible magnetic geometry. As a national focus for fusion-science research, collaboration and education, the Facility accommodates the study of basic plasma physics, advanced magnetic configurations and remote measurement systems for future fusion power plants.

This year saw the installation of several major upgrades to H-1 under a \$7M EIF grant, including a new plasma heating system and plasma diagnostics. A new magnetized linear plasma source "MAGPIE" for investigating interaction of plasma with potential fusion reactor wall materials was also commissioned. Techniques and systems pioneered on the heliac continue to be deployed on world-leading fusion devices in the US, Asia and Europe.

Among other research areas, the Plasma Theory and Modeling group focuses on the fundamental physics and the modelling of magnetic confinement fusion energy devices. The group has active research links with multiple fusion research institutes in both Europe and Asia. The Physics of Fluids group undertakes research into physics of fluid turbulence, nonlinear wave phenomena and rotating fluids, including applications to environmental and atmospheric physics, weather and climate. The BushLAN project aims to deploy provisionally patented wireless broadband systems to remote areas using distributed MIMO (Multiple transmitter and multiple receiver) techniques on the band I TV spectrum.

The Space Plasma, Power and Propulsion division conducts work on both basic and applied plasma physics. The core research areas involve experimental and theoretical aspects of expanding radiofrequency helicon plasmas applied to space science, space propulsion and hydrogen fuel cells. The discovery of current free double layers and of the Helicon Double Layer Thruster led to a contract with ASTRIUM-EADS, Europe's largest Space company, and an Australian Research Space Program grant. Work includes thrust measurement, prototype space qualification and plasma modeling and simulation. Furthermore, the laboratory double layers are being applied to understanding space plasma physics such as the magnetic funnels of the solar corona and the Earth's aurora. A large contract has been signed with LAM Research Corporation in Silicon Valley for the further development of an SP3 invention to be used for the next generation of plasma etching systems for microelectronics. This opens a new and exciting career path for students and researchers alike.

Academic Staff

Professor and Head, Toroidal Plasma

John Howard BSc PhD Sydney, FInstP

Professor and Head, Space Plasma, Power and Propulsion

Christine Charles BEng MSc Rennes, PhD Hab Orléans, BMus

Director, Australian Plasma Fusion Research Facility and Senior Fellow

Boyd Blackwell BSc PhD Sydney

Professors

Michael Shats MSc KPI, PhD GPI Moscow

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

Roderick Boswell BSc Adelaide, PhD Flinders, FTSE, FAPS

Fellows

Cormac Corr PhD Belfast

Gerard Borg BSc PhD Sydney

Matthew Hole BSc BE PhD Sydney

Research Fellows

Hua Xia, MSc Chongqing, PhD

Shuiliang Ma PhD (left in September)

Postdoctoral Fellow

Graham Dennis PhD

Gregory von Nessi BSc Massachusetts PhD

Michael Fitzgerald PhD University of Sydney

Visiting Fellows

Dr Amael Caillard, University of Orleans, France

Dr Christian Sarra-Bournet,

Dr Jerew Oday

Dr Jay Larson, Argonne National Laboratory, USA

Dr Kazunori Takahashi, Iwate University, Japan

Prof. Zensho Yoshida, University of Tokyo, Japan

General staff

Andrew Bish

Bernhard Seiwald , PhD Graz Uni. of Tech.

David Pretty, BSc Melb PhD

Fenton Glass BSc Queensland, PhD

Horst Punzmann BSc Regensburg, PhD

John Wach BAppSci CAE Ball, GradDipEI CCAE

Mark Gwynneth

Michael Blacksell

Peter Alexander

Departmental Administrator

Maxine Hewitt BA UC (until April)

Uyen Nguyen BA Monash (from April)

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 field for metrological and information technology applications. 2011 is the start of the new Centre of Excellence for Quantum Computation and Communication Technology, hosting programs for Secure Quantum Communication, Quantum Memory and Quantum Repeater. In 2011, the group has published 12 articles including papers in Nature Photonics, Nature Physics, Nature Communication, Optics Letters, and Applied Physics Letters. Major results include: the generation of Gigabits of random number by measuring vacuum fluctuations at optical frequencies; and the storage and noiseless recall of Quantum optical pulses in Rubidium vapour cells at room temperature. The efficiency of this “quantum memory” is the highest achieved in the world at 87%.

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 2011 for example, we developed a state of the art cold atom gravimeter.

The Centre for Gravitational Physics (CGP) 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 and earth observations. Highlights in 2011 include: producing the ‘quietest’ laser yet at audio frequencies; using this quantum enhancement to deliver the most sensitive gravitational wave detector ever built; and searching for gravitational waves from rapidly spinning neutron stars. We commenced collaboration with the National Measurement Institute to develop optical sensors for drug testing and our program to revolutionise the space-based Gravity Climate and Recovery Experiment by using an optical readout gathered

Academic Staff

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Professors

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Ping Koy Lam BSc Auckland, PhD

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Cristina Robins-Figl PhD Hannover

Jiri Janousek PhD DTU Denmark

Mattias Johnsson PhD Canterbury

Bram Slagmolen PhD

Robert Ward PhD Caltech (from November)

Postdoctoral Fellows

Syed Assad PhD NUS Singapore/ANU

Julien Bernu PhD ENS France

David Bowman PhD ADFA (from August)

Boris Hage PhD LUH Germany

Ra Inta PhD UNSW

John Miller PhD Glasgow

Conor Mow-Lowry PhD (from July)

Olivier Pinel PhD Paris

Alberto Stochino PhD Caltech

Visiting Fellows

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Dr Peter Riggs

Emeritus Prof John Sandeman

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Paul Tant

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Laura Walmsley

Assistant Administrative Officer

Gaye Buratto

Centre of Excellence for Quantum Computation and Communication Technology

Node Administrator

Kerrie Cook (until April)

Amanda White (from April)

GRACE FoM Project Administrator

Kerrie Cook (from April)

THEORETICAL PHYSICS



*Professor Murray Batchelor
Head of Department*

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 and Dr Vladimir Mangazeev lead research in (i) finite lattice systems, combinatorics and Painleve equations, (ii) computational approaches to scaling and universality in statistical physics, (iii) quantum geometry and three-dimensional integrable systems. Dr Xiwen Guan leads research on exactly solved (integrable) models in cold atoms and spin systems. Integrable models of this kind have been realized recently with the trapping and cooling of quantum gases in tightly confined optical wave guides.

Professor Murray Batchelor leads research on aspects of exactly solved models in statistical mechanics, most recently on understanding the implications of a remarkable connection between the theory of Yang-Baxter integrability for lattice models 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.

Academic Staff**Professor and Head of Department**

Murray Batchelor BSc (Hons) UNSW, PhD ANU,
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Lucia Lu