

## RESEARCH DEPARTMENTS

The Research School of Physical Sciences and Engineering is comprised of eight research departments, a brief description of each department is detailed in the following pages with a list of staff dedicated to that area.

A ninth department (Quantum Science) was formed in December 2008, effective 2009 and will be reported in the 2009 Annual Report.

- Applied Mathematics
- Atomic and Molecular Physics Laboratories
- Electronic Materials Engineering
- Laser Physics
- Nonlinear Physics
- Nuclear Physics
- Plasma Research Laboratory
- Theoretical Physics



#### RESEARCH CENTRES (located in the School)

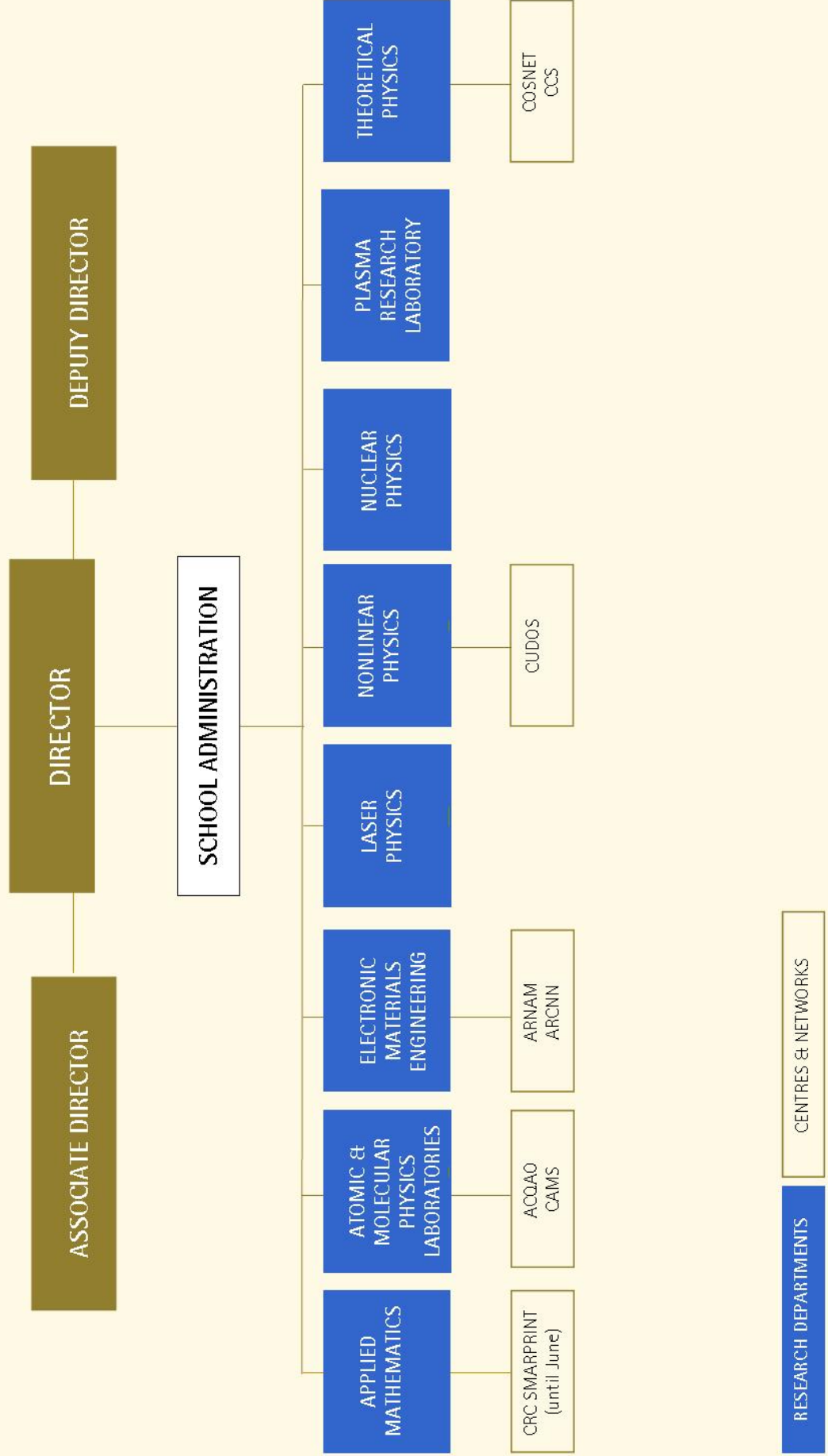
Many scientists at the School are involved in national and international collaborative work, and some are members of major research centres that span several host institutions.

- Australian Research Council Centre of Excellence for Quantum-Atom Optics (ACQAO)
- Australian Research Council Centre of Excellence for Antimatter-Matter Studies (CAMS)
- Centre for Complex Systems (CCS)
- Cooperative Research Centre for Functional Communication Surfaces (CRC Smartprint) - until June
- Australian Research Council Centre of Excellence for Ultrahigh Bandwidth Devices for Optical Systems (CUDOS)

#### RESEARCH NETWORKS (hosted by the School)

- Australian Research Council Nanotechnology Network (ARCNN)
- Australian Research Network for Advanced Materials (ARNAM)
- Australian Research Council Complex Open Systems Research Network (COSNet)

# Research School of Physical Sciences and Engineering 2008



RESEARCH DEPARTMENTS

CENTRES & NETWORKS

## Applied Mathematics



*Professor Mark Knackstedt*

The Department of Applied Mathematics performs research on fundamental and applied topics in colloid, surface and polymer science, largely in measurement of surface forces; on self-assembly of organic and inorganic structures at mesoscopic scales; and on disordered materials, mostly on micron-scale morphology, granular materials and transport in porous structures and on complex systems.

Although condensed matter and materials research dominates the Department's efforts, individual programs are diverse; for example, statistical mechanical studies of liquids at interfaces, role of specific ion effects on fluid interactions, modelling and experiments of multiphase flow properties of oil-bearing rocks, tomographic imaging of fossils and studies of networks and analysis of economic data are part of the group's ongoing research programs.

A significant part of the Department's effort has been funded by a large international consortium of oil and gas companies.

### *Academic Staff*

#### **Professor and Head of Department**

Mark Knackstedt BSc Columbia, PhD Rice

#### **Professors**

Stephen Hyde BSc PhD Monash, ARC Federation Fellow

David Williams BSc Sydney, PhD Cambridge

#### **Senior Fellows**

Tomaso Aste DipHons Genova, PhD Milan

Vince Craig BSc PhD

Tiziana Di Matteo BSc PhD Salerno

Tim Senden BSc PhD

Adrian Sheppard BSc Adelaide, PhD

#### **Research Fellows**

Christoph Arns DipPhys Aachen, PhD UNSW

Lilliana De Camp 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  
Rob Sok BSc PhD Groningen  
Trond Varslot MSc PhD NTNU Norway

#### **Postdoctoral Fellows**

Gary Delaney PhD Trinity Ireland  
Anthony Jones PhD  
Andrew Kingston PhD  
Shane Latham BSc UQ, PhD  
Mayhar Madadi BSc Tehran, MSc PhD IASBS  
Peter Wood BSc, PhD Flinders  
Pär Wedin MSc KTH Stockholm, PhD Karlstad

### *General Staff*

#### **Senior Software Developer**

Paul Veldkamp BSc BEc

#### **Technical Officers**

Anthony Hyde AssocIE  
Tim Sawkins

#### **Departmental Administrator**

Margo Davies DipDent Tasmania

### *Visiting Fellows*

*(external host institution indicated where applicable)*

Dr Christoph Arns, University of New South Wales (from April)  
Dr Ji-Youn Arns  
Dr Judith Caton (from February)  
Mr Arthur Davies  
Dr Gareth Delaney (from August)  
Professor Stjepan Marcelja  
Dr Yasmin Melean, University of Venezuela  
Dr Chiara Neto, University of Florence  
Professor Barry Ninham  
Mr Rodney Urquhart (from December)

## Atomic and Molecular Physics Laboratories



*Professor Brenton Lewis*

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, in order 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:

- Photons - VUV/XUV laser spectroscopy, laser photodetachment and photofragment spectroscopy, computational molecular physics, computational planetary atmospheres, computational multiple photo ionization;
- Electrons/Positrons - low-energy electron and positron physics (experimental and theoretical), materials studies with positrons, e-2e studies of gases, EMS studies of gases and solids; and
- Quantum-Atom Optics - He BEC studies, atom manipulation, experimental tests of led theory.

The Laboratories also host two Australian Research Council Centres of Excellence: the Australian Research Council Centre of Excellence for Quantum-Atom Optics (ACQAO), which plays a leading role in the study of the quantum properties of Bose-Einstein condensates and atom lasers via insights gained from quantum optics; and the Australian Research Council Centre of Excellence for Antimatter-Matter Studies (CAMS), whose experimental and theoretical program is based around the study of the interaction of electrons and positrons with matter.

### *Academic Staff*

#### **Professor and Head of Laboratories**

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

#### **Professors**

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

Stephen Buckman BSc PhD Flinders, FAPS, FAIP, FlnstP

Anatoli Kheifets BSc PhD St Petersburg, FAPS

#### **Adjunct Professors**

Lewis Chadderton DSc Durham, MA PhD Cambridge, C Phys, FlnstP, FAIP

Robert McEachran MSc PhD UWO, C Phys, FlnstP

**Senior Fellows**

Stephen Gibson BSc PhD Adelaide  
 Robert Robson BSc Queensland, DipMet BoM, PhD, FRMetS  
 Maarten Vos MSc PhD Gröningen

**Fellows**

Julian Lower BSc Adelaide, PhD Flinders  
 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  
 Igor Ivanov PhD DSc Moscow  
 Mitsuhiro Kono MSc KyotoIT, PhD GUAS Tokyo  
 Stan Newman BSc PhD Manchester

**Postdoctoral Fellows**

Susan Bellm BSc PhD Flinders  
 Antonio Garcia-Munoz MEng UPM, PhD York  
 Kandis Lea Jessup BSc Earlhan, MSc PhD Michigan (until August)  
 Casten Makochekanwa BSc Zimbabwe, MSc PhD Yamaguchi  
 Subhendu Mondal MSc PhD Banaras  
 Eskender Mume BSc PhD (located at ANSTO)  
 Daniel Slaughter BSc PhD Flinders  
 Michael Went BSc Newcastle, PhD Griffith

***General Staff*****Technical Officers**

Stephen Battisson AssocDip MechEng CIT  
 Graeme Cornish AssocDip MechEng CIT  
 Colin Dedman AssocDip Scilnst Bendigo CAE  
 Ross Tranter (from May)

**Departmental Administrator**

Deborah Bordeau CertIV SBM CIT

***Visiting Fellows***

Emeritus Professor Robert Crompton AM  
 Emeritus Professor Erich Weigold AM

## Electronic Materials Engineering



*Professor Robert Ellimann*

The Department of Electronic Materials Engineering undertake world-class interdisciplinary research into the growth, structure, properties, processing and applications of electronic materials and related structures and devices. The Department's diverse research program is underpinned by core expertise, a strong network of national and international collaborators, and a comprehensive suite of state-of-the-art equipment and facilities.

The department also hosts two Australian Research Council networks, the Australian Research Council Nanotechnology Network (ARCNN) and the Australian Research Network for Advanced Materials (ARNAM) as well as the ACT node of the NCRIS Fabrication Facility.

### *Academic Staff*

#### **Professor and Head of Department**

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

#### **Professors**

Chennupati Jagadish MSc PhD Delhi, FAA, FTSE, FAIP, FInstP, FloN, FIEEE, FAPS, FOSA FSPIE, FECS, FIET, FAAAS, FAVS, ARC Federation Fellow

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

#### **Senior Fellows**

Ying Chen BSc CAS, MSc Tsinghua, PhD Paris

Mark Ridgway BSc McM, MSc PhD Queens

Hoe Tan BE Melbourne, PhD

#### **Fellows**

Jenny Wong-Leung BSc Bristol, PhD

#### **Research Fellows**

Jodie Bradby BAppSc RMIT, PhD

Lan Fu MSc UTSC, PhD

Naoki Fujisawa BE Waseda MSc PhD UNSW

Haroldo Hattori MSc ITA Brazil, PhD VPISU Virginia

Patrick Kluth DipPhys Dusseldorf, PhD Jülich (from June)

#### **Postdoctoral Fellows**

Leandro Araujo MSc PhD UFRGS Brazil

Almamun Ashrafi MSc PhD Hokkaido

Qiang Gao MS BSc NEU China, PhD

Patrick Kluth DipPhys Dusseldorf, PhD Jülich (until June)



Wen Lei MSc CUG, PhD CAS  
Qing Li BSc BNU China, MSc CAS, PhD HKU  
Simon Ruffell MEng Surrey, PhD UWO Canada  
Avi Shalav PhD UNSW, MSc DipTchg Massey  
Dinesh Venkatachalam PhD RMIT, MSc BITS India (from July)

### *General Staff*

#### **Technical Officers**

Michael Aggett AssocDipMechEng CIT  
Dane Kelly (from June)  
Bernie King ONC London  
Craig Saint

#### **Research Assistants**

Kidane Belay MSc AAU Ethiopia, PhD  
David Llewellyn

#### **Departmental Administrator**

Renee Vercoe (until May)  
Scott Yates (from August)

### *Visiting Fellows*

*(external host institution indicated where applicable)*

Professor Neville Fletcher  
Dr Haroldo Hattori (from June)  
Dr Abdul Majid, University of Azad Jammu and Kashmir (until September)

## Laser Physics



*Professor Barry Luther-Davies*

Laser Physics are engaged in laser-based research on topics spanning fundamental and applied physics and engineering. Generally fundamental questions have been addressed in studies of the interaction of intense laser light with matter, nonlinear processes and ultra-high resolution spectroscopy of solids.

Research of more strategic nature includes work on photorefractive materials on the properties of solitons and other nonlinear waves, on nonlinear optical materials for photonics and quantum information. Applied research includes the development of novel parametric devices, techniques for the production of nonlinear waveguides, photonic crystal and other photonic devices.

Research highlights for 2008 have included:

- a breakthrough switching speed for photonic chips of 640Gb/s for all-optical processing; an RF spectrum analyser with a record bandwidth of >3THz; on-chip four wave mixing gain of >30dB; super continuum generation in a compact dispersion engineered waveguide; and optically-written high-Q 2-D photonic crystal resonators in chalcogenide glass membranes;
- the lowest loss TeO<sub>2</sub> waveguides ever reported as well as low loss nano-imprinted polysiloxane waveguides;
- discovery of ultrafast coherent displacement of atoms by a polarisation force in a laser-irradiated bismuth crystal;
- determination of the relaxation dynamics of the refractive index in laser-irradiated photorefractive LiTaO<sub>3</sub> and LiNbO<sub>3</sub> crystals used for a novel 3-D optical memory;
- the development of an optical trap based on optical vortices for capture and transport of agglomerates of nanoparticles in air;
- a solid-state quantum memory for light with up to 45% efficiency, the highest so far demonstrated for any system;
- the discovery that spin polarization in the nitrogen valency centre in diamond occurs through an intersystem crossing that can be monitored through infrared emission between singlet levels;
- the observation of second-harmonic conical waves formed by nonlinear Bragg diffraction in an annular periodically-poled nonlinear material;
- a new nonlocal nonlinear model to study pulse compression during second harmonic generation; and
- the formation and dynamics of rotating spatial solitons (azimuthons) in nonlocal nonlinear media.

Research in photonics has partly been supported by the Australian Research Council Centre of Excellence for Ultrahigh Bandwidth Devices for Optical Systems (CUDOS).

## *Academic Staff*

### **Professor and Head of Department**

Barry Luther-Davies BSc PhD S'ton, SIEE, FAIP, ARC Federation Fellowship (until October)

### **Professors**

Wieslaw Krolikowski MSc PhD Warsaw

Neil Manson MSc PhD Aberdeen

### **Senior Fellows**

Eugene Gamaly PhD DSc Moscow

Andrei Rode MSc PhD Moscow

Marek Samoc PhD DSc Wroclaw

### **Research Fellows**

Duk Yong Choi PhD Seoul

Steve Madden PhD Imperial College

Anna Samoc MSc PhD Wroclaw

Matthew Sellars BSc PhD

Rong Ping Wang PhD CAS

### **Postdoctoral Fellow**

Vesselin Kolev PhD (until April)

## *General Staff*

### **Technical Officers**

John Bottega

Tony Kerr

Maryla Krolikowska

Craig Macleod AssocDip MechEng CIT

Anita Smith BSc Flinders

Martin Wulf

### **Departmental Administrator**

Belinda Barbour

## *Visiting Fellows*

*(external host institution indicated where applicable)*

Dr Dax Kukulj

Dr Yongmin Li, Shanxi University

Mr Raju Malinger (from August)

Mr Jonathan Payne

Dr Yinlan Ruan, (until October)

Dr Anna Samoc (from October)

Dr Ming Shen, Shanghai University (from July)

## Nonlinear Physics



*Professor Yuri Kivshar*

Nonlinear Physics are engaged in theoretical and experimental interdisciplinary research in a number of diverse topics unified by the general concepts of nonlinear physics and nonlinear photonics. They continue to play an important role in two Australian Research Council Centres of Excellence: the Australian Research Council Centre of Excellence for Ultrahigh bandwidth Devices for Optical Systems (CUDOS); and the Australian Research Council Centre of Excellence for Quantum-Atom Optics (ACQAO). Nonlinear Physics also host a Student Chapter of the Optical Society of America. Nonlinear Physics are defined by five major research directions.

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, polychromatic light, nonlinear patterns and self-focusing, and more recently, singular optics and vortices. In 2008, the group's activities moved towards the nonlinear plasmonics and the physics of optical metamaterials.

The theoretical photonics group, led by Dr Andrey Sukhorukov undertakes the study of nonlinear waves and optical solitons. 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 group. More recently this included the development of novel concepts such as light transmission in complex and quasi-periodic media, light shaping and control in periodically modulated waveguide arrays. The majority of the group's projects are linked to the activities of CUDOS.

The singular photonics group, led by Dr Anton Desyatnikov undertakes both theoretical and experimental studies of the complex light with angular momentum, optical vortices, optical polarization singularities, and vortex lattices. The new activities in 2008 are associated with the development of a novel type of a double-vortex trap and the three-dimensional guiding and controlling of adsorbing nanoclusters in air.

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 lasers, quantum optics of nonclassical and squeezed light. More recently, the group developed several novel concepts, including the novel application of the ratchet effect to control the dynamics of matter-wave solitons in oscillating potentials.

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, this group demonstrated experimentally the first nonlinear metamaterial operating at microwaves. The group developed novel types of metamaterials including the structures with nonlinear electric response and backward-wave transmission lines.

## *Academic Staff*

### **Professor and Head of Department**

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

### **Senior Fellow**

Solomon Saltiel PhD DSc Bulgaria (June-September)

### **Fellows**

Anton Desyatnikov PhD Moscow

Dragomir Neshev MSc PhD Sofia

Elena Ostrovskaya MSc Moscow, PhD

Alexander Savin PhD Moscow (from October)

Andrey Sukhorukov MSc Moscow, PhD

### **Research Fellows**

Tristram Alexander PhD

Konstantin Bliokh PhD Kharkov (from April)

Chaohong Li PhD Beijing

Andrey Miroshnichenko PhD Dresden

Ilya Shadrivov PhD

Vladlen Shvedov PhD Ukraine (from April)

Xue-Hua Wang MSc Xiangtan, PhD Shanghai (to January)

### **Postdoctoral Fellows**

Yana Izdebskaya PhD Simferopol

Michal Matuszewski PhD Warsaw

David Powell PhD Monash

## *General Staff*

### **Research Assistant**

Artur Davoyan (to March)

### **Departmental Administrator**

Kathy Hicks DipAcct CIT

## *Visiting Fellows*

*(external host institution indicated where applicable)*

Dr Miklos Gulacsi, Max Planck Institute

Dr Sergey Kun, Universidad Nacional Autonoma de Mexico

Professor Mario Salerno, University of Salerno (from October)

Dr Jose Salguero, Universidade de Vigo (from October)

Professor Slobodan Vukovic, Institute of Physics (from September)

## Nuclear Physics



*Professor George Dracoulis*

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 Pelletron 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 (formerly the ANU-EPSRC 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 post-graduate 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 the study and use of hyperfine interactions for moment measurements and for elucidating nuclear structure. Both nuclear techniques and heavy-ion detection techniques are used in a range of materials science applications including materials modification and characterisation, while the technique of Accelerator Mass Spectrometry is applied extensively. It covers a broad range of topics with applications and basic research in archaeology, hydrology, climate change, soil erosion and trace isotopic analyses applied to environmental pollution studies, both nuclear and non-nuclear.

### *Academic Staff*

#### **Professor and Head of Department**

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

#### **Professors**

Keith Fifield MSc Auckland, PhD Penn, FAIP

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

**Senior Fellows**

Mahananda Dasgupta MSc Rajasthan, PhD Bombay, FAIP  
 Andrew Stuchbery BSc PhD Melbourne, FAIP

**Fellows**

Tibor Kibédi PhD Debrecen  
 Gregory Lane BSc PhD  
 Anna Wilson BSc Bristol, PhD Liverpool

**Research Fellows**

Timothy Barrows BSc PhD (until January)  
 Rickard Du Rietz MSc PhD Lund (from November)  
 Stephen Tims BSc PhD Melbourne

**Postdoctoral Fellows**

Sanjay Chamoli MSc BEd HNB Garhwal, PhD Chandigarh  
 Alexis Diaz-Torres MSc Havana, PhD Giessen  
 Toshiyuki Fujioka MSc Osaka, PhD  
 Leandro Gasques BSc PhD São Paulo (until January)  
 Renju Thomas BSc Kerala, MSc Cochin, PhD Mumbai (until January)

***General Staff*****Accelerator Research and Operations Manager**

David Weisser MSc, PhD Minn, FAIP

**Engineer**

Nikolai Lobanov BSc Moscow, PhD St Petersburg

**Technical Officers**

John Bockwinkel, AdvDip MechEng CIT  
 Alan Cooper, AssDip MechEng CIT  
 Alan Harding  
 Justin Heighway, AssDip AppSci CIT  
 John Kennedy  
 Tom Kitchen  
 Lorenzo Lariosa  
 Alistair Muirhead  
 Howard Wallace (deceased September)

**Departmental Administrator**

Petra Rickman

***Visiting Fellows***

*(external host institution indicated where applicable)*

Dr Rickard Du Rietz, Royal Physiographic Society (until November)  
 Dr Paivi Nieminen, University of Jyväskylä (until May)  
 Professor Ray Spear (until June)  
 Dr Wolf-Dietrich Zeitz, Hahn-Metner Institute (from September)

## Plasma Research Laboratory



*Dr Boyd Blackwell*



*Professor Rod Boswell*

The **Toroidal Plasma** group, led by Dr Boyd Blackwell, embraces a range of pursuits associated with the physics of magnetised plasma; the physics of fluids, electromagnetics, remote sensing and inverse methods. The group operates the National Plasma Fusion Research Facility based on the H-1 heliac, an innovative plasma confinement device with flexible geometry allowing exploration of basic plasma physics, advanced configurations and remote measurement systems for fusion power plants. The Plasma Configuration group's data mining techniques developed on H-1, are now being applied to the world's largest stellarators to unravel the mode structure of plasma instabilities. A precision magnetic surface mapping technique can resolve magnetic island structure, and some interesting effects on plasma confinement. The BushLAN project, a research-led teaching project led by Dr Borg, develops advanced wireless protocols and devices exploiting the new 'cognitive radio' spectrum to provide wireless broadband to remote areas.

Pioneering optical technologies developed by Professor Howard's Advanced Imaging and Inverse Methods group underpin collaborations on fusion research devices in the United Kingdom, the United States, Europe and Asia, and with Bluescope, on steel production. With Chalmers University in Sweden, the group is adapting inverse techniques, initially developed for plasma diagnostics, to microwave imaging of human tissue. The Physics of Fluids group, led by Dr Shats focuses on waves, turbulence and non-linear phenomena, important for the physics of weather, climate, and plasma confinement. Recent highlights include novel studies of spectrally condensed two-dimensional turbulence relevant to analysis of atmospheric wind data, the first simultaneous observation of inverse energy and forward enstrophy cascades in thin fluid layers, and commissioning of a new surface wave facility.

The **Space Plasma, Power and Propulsion** group, led by Professor Rod Boswell, 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 EADS/ASTRIUM, Europe's largest Space company. Experimental work includes thrust measurement, prototype optimisation and plasma detachment. In addition, the group has a major program to simulate and model the double layer phenomena observed in the laboratory plasma. Furthermore, the laboratory double layers are being applied to understanding space plasma physics such as the magnetic funnels of the solar corona. Other research on space plasma physics includes studying high-beta plasmas and wave-plasma interactions.

Funded by an Australian Research Council Discovery grant until 2009, this group is using dry plasma processing techniques to produce fuel cell electrodes and membranes. Employing carbon nanofibers in the electrodes the group has reduced the amount of catalyst while maintaining the fuel cell efficiency. A new plasma system will deposit new plasma polymer membranes.



## *Academic Staff*

### **Professors**

Roderick Boswell BSc Adelaide, PhD Flinders, FTSE, FAPS

John Howard BSc PhD Sydney, FlnstP

### **Senior Fellows**

Boyd Blackwell BSc PhD Sydney

Michael Shats MSc KPI, PhD GPI Moscow

Christine Charles BEng MSc Rennes, PhD Hab Orléans, BMus

### **Fellow**

Gerard Borg BSc PhD Sydney

### **Research Fellow**

Frank Detering BSc Oldenburg, PhD Saskatchewan

Ahmed Diallo PhD Iowa (from April)

Shantanu Padhi PhD Delhi (from February)

### **Postdoctoral Fellows**

Cormac Corr PhD Belfast

Hua Xia, MSc Chongqing, PhD

## *General Staff*

### **Research Engineer**

Horst Punzmann BSc Regensburg, PhD

### **Technical Officers**

Peter Alexander

Ananda Galagali Raghuttam

Mark Gwynneth

John Wach BAppSci CAE Ball, GradDipEI CCAE

### **Departmental Administrator**

Leanne Roberts

## *Visiting Fellow*

Mr Robert Powell (from May)

## Theoretical Physics



*Professor Murray Batchelor*

The Department of Theoretical Physics is one of the university's founding departments. The core research areas involve theoretical aspects of mathematical physics, plasmas and fluids, condensed matter physics and optical sciences. The Department is also host to the Australian Research Council Research Network on Complex Open Systems (COSNet) and the Centre for Complex Systems (CCS).

Research in the mathematical physics group is centred on two related areas of activity. These are string theory and integrable models. The string theory team is led by Professor Peter Bouwknegt. The main area of research focusses on the mathematical structures underlying string theory, in particular on duality symmetries and generalizations of geometry. This involves studying non-commutative and non-associative algebras, generalised geometries (in the sense of Hitchin) and T-dualities between these structures.

The integrable model team is led by Professors Murray Batchelor and Vladimir Bazhanov. Research is based on the development of theoretical models and methods of analysis for the exact physical description of fundamental interacting systems in statistical mechanics and quantum field theory. It includes the study of phase transitions and magnetic ordering in low-dimensional spin systems and cold atomic gases and the development of new approaches and applications in quantum geometry. Professor Bazhanov is convenor of the National Institute for Theoretical Physics Planning Committee.

The plasmas and fluids group is led by Professor Robert Dewar with the major research topic in complex, nonequilibrium systems. The area spans plasma physics, atmospheric physics, bushfire dynamics and other complex physical systems applications. Much of the research is focused on the fundamental physics and the modelling of magnetic confinement fusion energy devices. The group has active research links with the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Princeton Plasma Physics Laboratory, the United Kingdom Atomic Energy Authority (UKAEA) Fusion, among others. Dr Matthew Hole is Chair of the Australian International Thermonuclear Experimental Reactor (ITER) forum.

Research activity in the condensed matter theory group includes the theory of electron transport and noise in mesoscopic systems, high-temperature superconductivity, density functional theory of disordered systems, strongly correlated electrons, spintronics and semi-conductor devices.

The optical sciences group is led by Professors John Love and Nail Akhmediev and involves studies in nonlinear optics and soliton theory. The group develops basic theory of solitons for optical systems that includes modern all-optical information transmission lines and ultra-short pulse lasers. The group is strongly linked to experimental photonics groups within the School, across campus, and to international research laboratories.

## *Academic Staff*

### **Professor and Head of Department**

Murray Batchelor BSc UNSW, PhD, FAIP, FAustMS, FInstP

### **Professors**

Nail Akhmediev MS PhD DSc Moscow, FOSA

Vladimir Bazhanov PhD Serpukhov

Pier Bouwknegt MSc Utrecht, PhD Amsterdam, FAIP, FAustMS

Mukunda Das MSc Utkal, PhD Roorkee, FAIP, CPhys, FInstP

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

John Love MA Cambridge, MA DPhil DSc Oxford

### **Fellows**

Adrian Ankiewicz BSc BE UNSW, PhD

Rowena Ball BSc PhD Macquarie

Vladimir Mangazeev MSc Moscow, PhD Serpukhov

Wen Xu MSc PhD Antwerp

### **Research Fellows**

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

Matthew Hole BSc BE PhD Sydney

Ashwin Pande BSc Mumbai, MS PhD IISc Bangalore, MA PhD Maryland

Meelis Zidikeri BSc Melbourne, PhD (until June)

## *General Staff*

### **Departmental Administrator**

Caroline Ashlin

## *Visiting Fellows*

*(external host institution indicated where applicable)*

Professor Helen Au-Yang, Oklahoma State University (from August)

Professor Frederick Barker

Dr Kevin Bryant (from June)

Professor Wenjing Chen, Sichuan University (until September)

Dr Rong-Jian Du, Tianjin University of Technology (to July)

Dr Michael Hall

Dr Kailash Kumar

Dr Jay Walter Larson

Professor Jacques Perk, Oklahoma State University (from August)

Dr Brian Robson

Dr Sergey Sergeev (until July)

Dr Andrew Stewart

Dr Lindsay Tassie

Dr William Woolcock