



Dr David Williams

# Applied Mathematics

*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 and transport in porous structures.*

The Department during 2003 continued its long tradition of research into the broad areas of condensed matter and surface science. This includes much experimental work as well as theory and simulation of these systems. The research interests in condensed matter can be broadly classified into three main areas: (a) soft matter systems (polymers, liquid crystals, surfactants); (b) surface science – particularly systems involving colloidal and soft materials; (c) porous and disordered materials. Although condensed matter and materials research dominates the Department's efforts, there are also theoretical program areas as diverse as networks and analysis of economic data.

A large part of the Department's effort intermeshes strongly with the ARC Cooperative Research Centre, SmartPrint, which focuses mainly on paper research (Kackstedt, Senden and Craig). It involves in particular, use of the X-ray computed tomography facility, which enables 3D imaging of small samples of material at a resolution of 2 microns. This facility is a crucial part of much of the Department's experimental efforts and is also used to image rock samples for the petroleum industry and bone samples for applications in biotechnology.

The department is very large, comprising over 50 people, and in terms of academic staff is the largest in the Research School. It continues to grow, thanks mainly to inputs of money from industry and from the ARC in terms of fellowships, the CRC and grants. It is also very diverse, encompassing researchers with very different backgrounds and often very different approaches to research. Research ranges from the very esoteric through to highly applied work on petroleum extraction and papermaking. This is its great strength. In reality it is much like a physics, chemistry, biology, mathematics, materials and chemical engineering department all rolled into one. It also has a strong experimental component as well as theory and computer simulation. The Department has a very broad funding base amounting to over \$2M per annum. More than 60% of its budget comes from outside sources. This of course creates a very complicated budgetary situation.

During 2003 the research of the Department continued much as in recent years. The group led by Professor Steve Hyde developed its work on laboratory manufactured "fossils" which has garnered significant academic praise and media attention – as well as

derision—from the significant number of academics who have been upset by having the truth revealed. On the theoretical front work—continued on the self assembly of polymer toroids (Williams, Cooke and Hernandez-Zapata).

Another important area of research is experimental surface forces, either using the surface forces apparatus or one of the atomic force microscopes (Craig and Senden).

As can be seen from this brief and rather selective description, the Department is an applied mathematics department in name only, but thus far the name has been retained for historical reasons.

## Department Staff

### Head of Department

David Williams, BSc Sydney, PhD Cambridge  
(ARC Fellowship)

### Professors

Stephen Hyde, BSc PhD Monash

### Senior Fellow

Vassili Yaminsky, DipHons PhD Moscow  
Andrew Stewart, MA ScD Cambridge, AM Harvard, EE Col, DIC  
PhD London, FAIP (attached from Theory Cluster)

### Fellows

Tomaso Aste, DipHons Genova, PhD Milan (EU, Marie Curie Fellow)  
Mark Knackstedt, BSc Columbia,  
PhD Rice (ARC QEII Fellowship)  
Tiziana Di Matteo, BSc (Hons) PhD Salerno (ARC QEII Fellowship)

### Research Fellows

Christoph Arns, Dipl-Phys Aachen, PhD UNSW  
Vince Craig, BSc PhD ANU (ARC Fellowship)  
Satomi Ohnishi, BSc SUT Tokyo, PhD Saitama (ARC QEII  
Fellowship)  
Tim Senden, BSc PhD ANU (ARC Fellowship)  
Adrian Sheppard, BSc Adel,  
PhD ANU  
Rob Sok, BSc PhD Groningen

**Postdoctoral Fellows**

Armin Bauer, Dipl-Chem  
 Dr.Rer.Nat Regensburg  
 Fabrice Bauge, PhD Paris XI  
 Ernesto Hernandez-Zapata, BSc PhD UNA Mexico  
 Mika Kohonen, BSc PhD ANU  
 Christian Kugge, PhD KTH Stockholm (STINT Scholarship)  
 Ann-Kristin Larsson, Ma Sc Lic PhD Lund, Doc Stockholm  
 Chiara Neto, BSc(Hons), PhD Florence  
 Vanessa Robins, BSc ANU, PhD Colorado  
 Arthur Sakellariou, BSc PhD Melbourne

**Computational & Visualisation Consultants**

Stuart Ramsden, GradDip Film & Television Swinburne  
 Ray Roberts, BSc(For) CRC Administrator  
 Holger Averdunk, BSc(Hons) Biochemistry, BSc Computer Science

**Visiting Fellows**

Anna Carnerup, BSc Malmo (until February)  
 Arthur Davies, BSc ANU  
 Eugene Gamaly, PhD DSc Moscow (jointly with LPC)  
 Bruce Hyde, BSc Bristol, PhD DSc  
 Stjepan Marcelja, Dip.Ing Zagreb, PhD Roch, FAA  
 Yoshinori Nagai, DScWaseda  
 Barry Ninham, MSc WA PhD Maryland, DTech (hon causa) KTH  
 Stockholm, D Phil (hon causa) Lund, FAA  
 Ewa Radlinska, MSc Warsaw, PhD ANU (until January)

**Senior Technical Officers**

Anthony Hyde, Assoc IE Aust  
 Tim Sawkins

**Departmental Administrator**

Cindy Bradley (Part-time)

**Department Publications**

Legend: \* External to the University, # Member of another area of this University other than this School, † Author having a joint appointment across departments within the School

**Publications in Refereed Journals**

Anderson, S.\* and Ninham, B.W.  
*Why Ice Floats on Water*  
*Solid State Sciences* 5 (2003) 683-693

Arns, C., Sakellariou, A., Senden, T.J., Sheppard, A.P., Sok, R.M., Pinczewski, W.V.\* and Knackstedt, M.A.  
*Petrophysical Properties Derived from X-ray CT Images*  
*APPEA Journal* 43 (2003) 577-586

Arns, C., Knackstedt, M.A. and Mecke, K.\*  
*Reconstructing Complex Materials via Effective Grain Shapes*  
*Physical Review Letters* 91 (2003) 215506-1-4

Arns, J.-Y.W., Arns, C., Sheppard, A.P., Sok, R.M., Knackstedt, M.A. and Pinczewski, V.\*  
 Relative Permeability from Tomographic Image:  
*Effect of Correlated Heterogeneity*  
*Journal of Petroleum Science and Engineering* 39 (2003) 247-259

Aste, T. and Coniglio, A.\*  
*Cell Approach to Glass Transition*  
*Journal of Physics: Condensed Matter* 15 (2003) S803-S811

Aste, T. and Coniglio, A.\*  
*Glasses and Local Packings*  
*Physica A* 330 (2003) 189-194

Atkin, R.\*, Craig, V., Wanless, E.\* and Biggs, S.\*  
*Adsorption of 12-s-12 Gemini Surfactants at the Silica-aqueous Solution Interface*  
*Journal of Physical Chemistry B* 107 (2003) 2978-2985

Atkin, R.\*, Craig, V., Hartley, P.\*, Wanless, E.\* and Biggs, S.\*  
*Adsorption of Ionic Surfactants to a Plasma Polymer Substrate*  
*Langmuir* 19 (2003) 4222-4227

Atkin, R.\*, Craig, V., Wanless, E.\* and Biggs, S.\*  
*Mechanism of Cationic Surfactant Adsorption at the Solid-aqueous Interface*  
*Advances in Colloid and Interface Science* 103 (2003) 219-304

Atkin, R.\*, Craig, V., Wanless, E.\* and Biggs, S.\*  
*The Influence of Chain Length and Electrolyte on the Adsorption Kinetics of Cationic Surfactants at the Silica-aqueous Solution Interface*  
*Journal of Colloid and Interface Science* 266 (2003) 236-244

Becheri, A.\*, Lo Nostro, P.\*, Ninham, B.W. and Baglioni, P.\*  
*The Curious World of Polypseudorotaxanes: Cyclodextrins as Probes of Water Structure*  
*Journal of Physical Chemistry B* 107 (2003) 3979-3987

Berbenni, V.\*, Marini, A.\*, Welham, N.J., Galinetto, P.\* and Mozatti, M.\*  
*The Effect of Mechanical Milling on the Solid State Reactions in the Barium Oxalate-iron(III) Oxide System*  
*Journal of the European Ceramic Society* 23 (2003) 179-187

Bonaccorso, E.\*, Butt, H.-J.\* and Craig, V.  
*Surface Roughness and Hydrodynamic Boundary Slip of a Newtonian Fluid in a Completely Wetting System*  
*Physical Review Letters* 90 (2003) 144501-1-4

Boström, M., Williams, D.R.M., Stewart, P.R. and Ninham, B.W.  
*Hofmeister Effects in Membrane Biology: The Role of Ionic Dispersion Potentials*  
*Physical Review E* 68 (2003) 041902-1-6

Boström, M., Craig, V., Albion, R., Williams, D.R.M. and Ninham, B.W.  
*Hofmeister Effects in pH Measurements: Role of Added Salt and Co-ions*  
*Journal of Physical Chemistry B* 107 (2003) 2875-2878

Boström, M., Longdell, J.J., Mitchell, D.J. and Ninham, B.W.  
*Resonance Interaction Between One Excited and One Ground State Atom*  
*The European Physical Journal D* 22 (2003) 47-52

Boström, M., Williams, D.R.M. and Ninham, B.W.  
*Specific Ion Effects: The Role of Co-ions in Biology*  
*Europhysics Letters* 63 (2003) 610-615

Boström, M., Williams, D.R.M. and Ninham, B.W.  
*Specific Ion Effects: Why the Properties of Lysozyme in Salt Solutions Follow a Hofmeister Series*  
*Biophysical Journal* 85 (2003) 686-694

Chan, A.\*, Rode, A.V., Gamaly, E.G.†, Luther-Davies, B., Taylor, B.\*, Dawes, J.\*, Lowe, M.\* and Hannaford, P.\*  
*Ablation of Dental Enamel Using Subpicosecond Pulsed Lasers*  
*International Congress Series* 1248 (2003) 117-119

Craig, V. and Plunkett, M.\*  
*Determination of Coupled Solvent Mass in Quartz Crystal Microbalance Measurements Using Deuterated Solvents*  
*Journal of Colloid and Interface Science* 262 (2003) 126-129

- Cruz, S.A.\*; Gamaly, E.G.†, Chadderton, L.T. and Fink, D.\*  
*A Simple Model for Latent Track Formation Due to Cluster Ion Stopping and Fragmentation in Solids*  
*Radiation Measurements* 36 (2003) 145-149
- Di Matteo, T., Aste, T. and Dacorogna, M.\*  
*Scaling Behaviors in Differently Developed Markets*  
*Physica A* 324 (2003) 183-188
- García-García, F.J.\*; Larsson, A.-K. and Furuseth, S.\*  
*The Crystal Structure of  $\text{Ni}_3\text{Sn}_2\text{P}_2$  Elucidated from HREM*  
*Solid State Sciences* 5 (2003) 205-217
- García-Ruiz, J.\*, Hyde, S.T., Carnerup, A., Christy, A., Van Kranendonk, M.\* and Welham, N.J.  
*Self-assembled Silica-carbonate Structures and Detection of Ancient Microfossils*  
*Science* 302 (2003) 1194-1197
- Golberg, D.\*, Rode, A.V., Bando, Y.\*, Mitome, M.\*, Gamaly, E.G.† and Luther-Davies, B.  
*Boron Nitride Nanostructures Formed by Ultra-high-repetition Rate Laser Ablation*  
*Diamond and Related Materials* 12 (2003) 1269-1274
- Hyde, S.T., Ramsden, S.J., Di Matteo, T. and Longdell, J.J.  
*Ab-initio Construction of Some Crystalline 3D Euclidean Networks*  
*Solid State Sciences* 5 (2003) 35-45
- Hyde, S.T., Larsson, A.-K., Di Matteo, T., Ramsden, S.J. and Robins, V.  
*Meditation on an Engraving of Fricke and Klein (The Modular Group and Geometrical Chemistry)*  
*Australian Journal of Chemistry* 56 (2003) 981-1000
- Hyde, S.T. and Schröder, G.  
*Novel Surfactant Mesostructural Topologies: Between Lamellae and Columnar (Hexagonal) Forms*  
*Current Opinion in Colloid and Interface Science* 8 (2003) 5-14
- Hyde, S.T. and Ramsden, S.J.  
*Some Novel Three-dimensional Euclidean Crystalline Networks Derived from Two-dimensional Hyperbolic Tilings*  
*European Physical Journal B* 31 (2003) 273-284
- Juodkazis, S.\*, Rode, A.V., Gamaly, E.G.†, Matsuo, S.\* and Mizawa, H.\*  
*Recording and Reading of Three-dimensional Optical Memory in Glasses*  
*Applied Physics B Lasers and Optics* 77 (2003) 361-368
- Kaneko, D.\*, Narita, T.\*, Gong, J.\*, Osada, Y.\*, Ando, J.\*, Yamamoto, K.\*, Ohnishi, S. and Yaminsky, V.V.  
*Thickness Decrease of a Grafted Polyelectrolyte Membrane Exposed to Shear Flow*  
*Journal of Polymer Science, Part B: Polymer Physics* 41 (2003) 2808-2815
- Knackstedt, M.A., Arns, C. and Pinczewski, W.V.\*  
*Velocity-porosity Relationships, 1: Accurate Velocity Model for Clean Consolidated Sandstones*  
*Geophysics* 68 (2003) 1822-1834
- Lo Nostro, P.\*, Ninham, B.W., Fratoni, L.\*, Palma, S.\*, Manzo, R.\*, Allemandi, D.\* and Baglioni, P.\*  
*Effect of Water Structure on the Formation of Coagels from Ascorbyl-Alkanoates*  
*Langmuir* 19 (2003) 3222-3228
- Neto, C.\*, Craig, V. and Williams, D.R.M.  
*Evidence of Shear-dependent Boundary Slip in Newtonian Liquids*  
*European Physical Journal E* 12 (2003) S71-S74
- Ninham, B.W.  
*The Confederacy in Retreat: An Appreciation of Sten Andersson*  
*Solid State Sciences* 5 (2003) 31-33
- Notley, S.\*, Biggs, S.\* and Craig, V.  
*Application of a Dynamic Atomic Force Microscope for the Measurement of Lubrication Forces and Hydrodynamic Thickness Between Surfaces Bearing Adsorbed Polyelectrolyte Layers*  
*Macromolecules* 36 (2003) 2903-2906
- Notley, S.\*, Biggs, S.\* and Craig, V.  
*Calibration of Colloid Probe Cantilevers Using Dynamic Viscous Response of a Confined Liquid*  
*Review of Scientific Instruments* 74 (2003) 4026-4032
- Ogney, C.\*, Rivier, N.\* and Aste, T.  
*Stratifications of Cellular Patterns: Hysteresis and Convergence*  
*European Physical Journal B* 33 (2003) 447-455
- Roberts, R., Senden, T.J., Knackstedt, M.A. and Lyne, M.B.\*  
*Spreading of Aqueous Liquids in Unsized Papers is by Film Flow*  
*Journal of Pulp and Paper Science* 29 (2003) 123-131
- Rode, A.V., Gamaly, E.G.†, Luther-Davies, B., Taylor, B.T.\*, Graessel, M.\*, Dawes, J.M.\*, Chan, A.\*, Lowe, R.M.\* and Hannaford, P.\*  
*Precision Ablation of Dental Enamel Using a Subpicosecond Pulsed Laser*  
*Australian Dental Journal* 48 (2003) 233-239
- Schröder, G., Ramsden, S.J., Christy, A.G. and Hyde, S.T.  
*Medial Surfaces of Hyperbolic Structures*  
*European Physical Journal B* 35 (2003) 551-564
- Senatore, C.\*, Polichetti, M.\*, Zola, D.\*, Di Matteo, T., Giunchi, G.\* and Pace, S.\*  
*Harmonic Susceptibilities and Pinning Properties of  $\text{Mg}_2\text{B}$  Bulk Superconductors*  
*Physica C - Superconductivity and its Applications* 388-389 (2003) 161-162
- Senatore, C.\*, Polichetti, M.\*, Zola, D.\*, Di Matteo, T., Giunchi, G.\*, Ceresara, S.\* and Ripamonti, G.\*  
*Study of the Vortex Dynamic in  $\text{Mg}_2\text{B}$  by Harmonic Susceptibility Measurements*  
*International Journal of Modern Physics B* 17 (2003) 655-660
- Senatore, C.\*, Polichetti, M.\*, Zola, D.\*, Di Matteo, T., Giunchi, G.\* and Pace, S.\*  
*Vortex Dynamics and Pinning Properties Analysis of  $\text{Mg}_2\text{B}$  Bulk Samples by ac Susceptibility Measurements*  
*Superconductor Science and Technology* 16 (2003) 183-187
- Stewart, A.M.  
*Vector Potential of the Coulomb Gauge*  
*European Journal of Physics A* 24 (2003) 519-524
- Stewart, A.M.  
*Wave Mechanics without Gauge Fixing*  
*Journal of Molecular Structure: Theochem* 626 (2003) 47-51
- Tuohimaa, A.\*, Paasi, J.\*, De Luca, R.\* and Di Matteo, T.  
*Three-dimensional Josephson Junction Networks with Coupling Inhomogeneities in Magnetic Fields*  
*Physica C - Superconductivity and its applications* 398 (2003) 41-48
- Yaminsky, V.V. and Stewart, A.M.  
*Interaction of Glass Surfaces in Air: Dispersion Forces in the Retarded Regime*  
*Langmuir* 19 (2003) 4037-4039
- Yaminsky, V.V. and Ohnishi, S.  
*Physics of Hydrophobic Cavities*  
*Langmuir* 19 (2003) 1970-1976
- Zergioti, I.\*, Papazoglou, D.G.\*, Karaiskou, A.\*, Fotakis, C.\*, Gamaly, E.G.† and Rode, A.V.  
*A Comparative Schlieren Imaging Study Between ns and sub-ps Laser Forward Transfer of Cr*  
*Applied Surface Science* 208-209 (2003) 177-180 (also listed under Laser Physics Centre)
- Refereed Conference Proceedings
- Roberts, R., Senden, T.J. and Knackstedt, M.A.  
*3D Imaging of the Spreading and Penetration of Aqueous Liquids into Unsized and Sized Papers*  
*5th International Paper and Coating Chemistry Symposium 2003, Montreal, Canada* (2003) 303-311
- Sakellariou, A., Sawkins, T., Senden, T.J., Arns, C., Limaye, A.\*, Sheppard, A.P., Sok, R.M., Knackstedt, M.A., Pinczewski, W.V.\*, Inge Berge, L.\* and Oren, P.\*  
*Micro-CT Facility for Imaging Reservoir Rocks at Pore Scales*  
*SEG, International Exposition and Seventy-Third Annual Meeting, Dallas, USA* (2003) 1-4
- Stewart, A.M.  
*Capacitance Dilatometry in a Surface Force Apparatus*  
*27th Annual A&NZIP Condensed Matter and Materials Meeting, Wagga Wagga* (2003) WW03-02 (3pages)
- Zergioti, I.\*, Papazoglou, D.G.\*, Gamaly, E.G.†, Rode, A.V. and Fotakis, C.\*  
*Studies on Ultra-short Laser Micro Structuring*  
*Advanced Optical Processing of Materials Symposium, San Francisco, USA* (2003) 143-148



Professor Brenton Lewis

# Atomic and Molecular Physics Laboratories

*Atomic, Molecular and Optical Physics is both a fundamental and enabling science that supports many other important areas of science and technology. Staff of these Laboratories pursue a broad spectrum of experimental and theoretical research into the structure of atoms, molecules, and solids, and their interactions with electrons, positrons, and photons.*

As recognised by the Division of Atomic, Molecular, and Optical (AMO) Physics of the American Physical Society, "AMO physics is an enabling science that supports many other important areas of science and technology". Indeed, students graduating in AMO physics acquire a breadth of knowledge and skills, enabling them to contribute to many areas of science, technology, and society. AMO physicists have also appeared prominently among Nobel laureates in recent times. The Atomic and Molecular Physics Laboratories are engaged in a broad range of experimental and theoretical 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.

During the year, the Department bade farewell to Radmila Panajotovic and Vladimir Sashin: we thank them for their contributions and wish them well in their new positions. Conversely, we welcomed Frank Mills (jointly with CRES), Jun Matsumoto, Michael Lange, and Robert Dall to new appointments, together with two new PhD research students, Cheng Chen and Cameron Bowles, and three Honours students. In addition, we hosted five international visiting scholars, two third-year students, and two summer scholars who were involved in brief research projects. Congratulations are in order for Robert Robson, who was appointed as an Adjunct Professor, and Andrew Truscott, who was promoted to Fellow. Finally, construction was completed this year of the new building wing (The Erich Weigold Building) which now houses most of the Department's experimental laboratories. Together with the refurbishment of the East Cockcroft wing, due for completion in 2004, this important development has served to consolidate Departmental staff and activities, currently in disparate locations, into a single area, and should lead to operational efficiencies and improved intra-Departmental interactions.

Members of the Department were again successful in winning grants, awards, and other marks of distinction during the year. The Department won four grants in the ARC Discovery round, resulting in funding on the order of \$400K p.a. (Weigold, Gibson, Sullivan and Kheifets). In addition a successful LIEF application for a National Positron Facility brought in funding of over \$800K

(Buckman) and \$30K seed funding to assist the preparation of a full application for an ARC research network in Optical and Quantum Science was secured (Baldwin). Brenton Lewis won DEST and Victorian Government funding of \$77K as sponsorship for the Fourteenth International Conference on Vacuum Ultraviolet Radiation Physics that he is chairing in Cairns next July. \$140K from the Major Equipment Committee to further efforts in photodetachment and photofragment spectroscopy was also won (Gibson and Cavanagh). Finally, we congratulate Andrew Truscott, who won the Australian Academy of Sciences Early-Career Researcher Award, and Thomas Hanna, who won the General Sir John Monash Award which will enable his DPhil studies at Oxford University.

The international research profile of the Department remains strong, as evidenced, not only by invitations to speak at international conferences, but also by an ongoing commitment to 48 collaborative projects, most involving international collaborators. Of approximately 50 refereed Departmental publications this year, over two-thirds have international coauthors.

## Department Staff

### Professor and Head of Laboratories

Brenton Lewis, PhD DSc Adel, C Phys, FlInstP, FAPS, FOSA, FAIP

### Professors

Stephen Buckman, BSc PhD Flind, FAPS, FAIP

Erich Weigold, BSc Adel, PhD ANU, FAA, FTSE, FAPS, FAIP

### Adjunct Professors

Lewis Chadderton, DSc Dur, MA PhD Camb, C Phys, FlInstP, FAIP

Robert McEachran, MSc PhD UWQ, C Phys, FlInstP

Robert Robson, BSc Qld, DipMet PhD, FRMS, FAPS, FAIP (from October)

### Senior Fellows

Ken Baldwin, MSc ANU, DIC PhD Lond, FAIP, FOSA (joint project with Laser Physics Centre)

Anatoli Kheifets, BSc PhD St Pet (jointly with Theoretical Physics)

Maarten Vos, MSc PhD Gron



**Fellows**

Stephen Gibson, BSc PhD Adel  
Julian Lower, BSc PhD Flind

**Research Fellows**

Mitsuhiko Kono, MS Kyoto IT, PhD Grad U Adv Sci  
Jun Matsumoto, MSc PhD Tokyo Met (from September)  
Franklin Mills, BSE Princ, MS PhD Caltech (from July) (jointly with CRES)  
Andrew Truscott, BSc PhD Qld (ARC Centre for Quantum Atom Optics)

**Postdoctoral Fellows**

Steven Cavanagh, BSc PhD Griff (ARC Fellowship)  
Robert Dall, BSc CQld (from November)  
Michael Lange, Dip. Phys Dr rer nat Heid (ARC Linkage) (from March)  
Radmila Panajotovic, MSc PhD Belgr (until December)  
Vladimir Sashin, BSc Mosc, PhD Flind (until May)

**Visiting Fellows**

John Carver, MSc Syd, PhD ScD Camb, AM, FAA, FTS, FAIP (Emeritus Professor)  
Robert Crompton, BSc PhD Adel, AM, FAA, FlinstP, FAPS, HonFAIP (Emeritus Professor)  
Malcolm Elford, BSc PhD Adel  
Harald Friedrich, DipPhys Freib, Dr rer nat Munst, (jointly with Theoretical Physics) (until March)  
Robert Robson, BSc Qld, DipMet, PhD, FRMS, FAPS, FAIP (jointly with Theoretical Physics) (until October)  
Theodore Stapinski, BE Qld, ME NSW, FTSE, FIE Aust (from November)

**Senior Technical Officers**

Stephen Battison, AssocDipMechEng CIT  
Graeme Cornish, AssocDipMechEng CIT  
Colin Dedman, AssocDipScilnst Bdgo CAE  
Kevin Roberts, MechTechCert SAIT

**Technical Officer**

Gary Picker, AssocDipMechEng CIT

**Departmental Administrator**

Alice Duncanson

**Department Publications**

Legend: \* External to the University, # Member of another area of this University other than this School, † Author having a joint appointment across departments within the School

**Books and Book Chapters**

Brunger, M.\*, Buckman, S.J. and Elford, M.T.  
*Excitation Cross Sections in Photon and Electron Interactions with Atoms, Molecules and Ions*, Springer-Verlag, Germany (2003) 6.118-6.201

Buckman, S.J., Brunger, M.\* and Elford, M.T.  
*Integral Elastic Cross Sections in Photon and Electron Interactions with Atoms, Molecules and Ions*, Springer-Verlag, Germany (2003) 6.52-6.84

Elford, M.T., Buckman, S.J. and Brunger, M.\*  
*Elastic Momentum Transfer Cross Sections in Photon and Electron Interactions with Atoms, Molecules and Ions*, Springer-Verlag, Germany (2003) 6.85-6.117

Kheifets, A.S.†  
*Close-coupling Approach to Multiple-atomic Ionization in Many-particle Quantum Dynamics in Atomic and Molecular Fragmentation*, Springer-Verlag, Germany (2003) 137-151

Schmidt-Böcking, H.\*, Mergel, V.†, Dörner, R.\*, Lüdde, H.\*, Schmidt, L.\*, Weber, T.†, Weigold, E. and Kheifets, A.S.†  
*Fast p-He Transfer Ionization Processes: A Window to Reveal the Non-s<sub>2</sub> Contributions in the Momentum Wave Function of Ground-state He in Many-particle Quantum Dynamics in Atomic and Molecular Fragmentation*, Springer-Verlag, Germany (2003) 353-378

**Publications in Refereed Journals**

Bolognesi, P.†, Kheifets, A.S.†, Bray, I.†, Malegat, L.†, Selles, P.†, Kazansky, A.K.\* and Alvadi, L.\*  
*A Procedure to Extract the Complex Amplitudes of He Photodouble Ionization from Experimental Data*  
*Journal of Physics B: Atomic, Molecular and Optical Physics* 36 (2003) L241-L247

Carver, J.H., Crompton, R.W., Ellyard, D.G.†, Hibbard, L.U.\* and Inall, E.K.\*  
*Marcus Laurence Elwin Oliphant 1901-2000*  
*Historical Records of Australian Science* 14 (2003) 337-364

Chadderton, L.T.  
*Nuclear Tracks in Solids: Registration Physics and the Compound Spike*  
*Radiation Measurements* 36 (2003) 13-34

Chatzidimitriou-Dreismann, C.A.†, Vos, M., Kleiner, C.\* and Abdul-Redah, T.\*  
*Comparison of Electron and Neutron Compton Scattering from Entangled Protons in a Solid Polymer*  
*Physical Review Letters* 91 (2003) 057403-1-4

Cho, H.†, Gulley, R.J. and Buckman, S.J.  
*Elastic Electron Scattering from Krypton at Backward Angles*  
*Journal of the Korean Physical Society* 42 (2003) 71-75

Cruz, S.A.†, Gamaly, E.G.†, Chadderton, L.T. and Fink, D.\*  
*A Simple Model for Latent Track Formation Due to Cluster Ion Stopping and Fragmentation in Solids*  
*Radiation Measurements* 36 (2003) 145-149

Demesie, A.M.†, Darewych, J.W.†, McEachran, R.P. and Stauffer, A.D.\*  
*Contribution of the Breit Interaction to Electron Scattering from Heavy Atoms*  
*Journal of Physics B: Atomic, Molecular and Optical Physics* 36 (2003) 665-674

Dorn, A.†, Kheifets, A.S.†, Schröter, C.D.†, Höhr, C.†, Sakhelashvili, G.†, Moshhammer, R.†, Lower, J.C.A. and Ullrich, J.†  
*Appearance and Disappearance of the Second Born Effects in the (e,3e) Reaction in He*  
*Physical Review A* 68 (2003) 012715-1-4

Espinosa, G.†, Golzarri, J.I.†, Vazquez, C.†, Fragoso, R.†, Chadderton, L.T. and Cruz, S.A.\*  
*AFM Observations of Latent Fission Tracks on Surfaces: Amorphous SiO<sub>2</sub> and Quartz*  
*Radiation Measurements* 36 (2003) 225-228

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Professor Rob Elliman

# Electronic Materials Engineering

*The Electronic Materials Engineering (EME) Department undertakes internationally competitive research into the growth, structure, properties, processing and applications of electronic materials and related structures and devices, and plays an important role in the training of undergraduates, postgraduates and other early career researchers*

The Department's diverse research program is supported by a comprehensive suite of state-of-the-art equipment and facilities and underpins a strong collaborative network and an ability to attract students and researchers from a range of disciplines.

The Department's research productivity has always been one of its key strengths and this year's performance is no exception with over 60 papers published in peer-reviewed journals and around 12 invited or keynote talks presented at national or international conferences. In addition, the Department's impressive success in the 2003 competitive grant round has seen six new postdoctoral fellows, an outcome that has brought new skills and expertise to the Department and thereby added to the breadth and depth of its research program, as well as adding new opportunities for collaboration and training. Success in the 2003/2004 funding round will further enhance the Department's research activities as well as see several new equipment items installed over the next year, including a high-resolution mask aligner (MEC) and a state-of-the-art sputter deposition system (ARC-Linkage Infrastructure).

In addition to their impressive research performance, EME staff and students also contributed their time in support of the School, University and professional bodies. This included service to committees, professional societies, national and international conferences, granting agencies and journals, as well as contributions to undergraduate teaching, the supervision of honours and PhD students, and participated in outreach activities such as summer schools and related activities. Staff and students again received many promotions, appointments and awards in recognition of these broader contributions, all of which are detailed elsewhere in this report. Of particular note, however, are the promotions of Ying Chen (level D) and Jenny Wong-Leung (level C), the presentation of ANU Awards to Michael Aggett (General Staff Excellence), and Mark Ridgway (Excellence in Supervision) and the election to Fellowship of the American Physical Society of Chennupati Jagadish. Also worthy of mention is the awarding of PhDs to Christine Carmody, Chris Glover and Tessica Weijers, and of an AINSE prize for best student poster presentation to Marc Spooner for a presentation at the 13<sup>th</sup> Nuclear Techniques of Analysis Conference.

This year saw two significant staff changes resulting from restructuring of the Department's technical resources and the redeployment of the Department's administrative assistant. Specifically, Renee Vercoe was appointed as Departmental Administrator, and Fred Johnson as the general staff member responsible for the Department's high-profile accelerator laboratories. As an experimental department with an extensive suite of experimental facilities EME relies very heavily on the dedication and expertise of its technical staff (Michael Aggett, Tom Halstead, Fred Johnson and Bernie King) as well as that of the School workshop (mechanical and electronic) and service staff. The Department also acknowledges the increasingly important role played by its technical assistants (Martin Conway, Yu Jun, David Llewellyn and Bettina Wolpensinger).

## Department Staff

### Professor and Head of Department

Rob Elliman, BAppSci, MAppSci RMIT, PhD, DSc Salf, FAIP, FIP

### Professors

C. Jagadish, BSc Nagarjuna, MSc (Tech) Andhra, MPhil PhD Delhi, FAIP, FIP, FIoN, FIEEE, FTSE, FAPS

Jim Williams, BSc PhD NSW, FAA, FTSE, FAIP, FIEAust

### Senior Fellows

Mark Ridgway, BSc McM MSc PhD Queen's

### Fellow

Ying Chen, BSc CAS MSc Tsinghua, PhD Paris (ARC Fellowship)

Mladen Petracic, MSc Zagreb, PhD ANU

Hoe Tan, BE Melb, PhD ANU (ARC QEII Fellowship)

### Research Fellows

Manuela Buda, PhD Eindhoven

Sanju Deenapanray, BEng MSc Pretoria, PhD ANU (ARC Fellowship)

Jenny Wong-Leung, BSc Bristol, PhD ANU (ARC QEII Fellowship)

**Postdoctoral Fellow**

Jodie Bradby, BApSc RMIT, PhD ANU (ARC Fellowship)  
 Lan Fu, MSc UTSC, PhD ANU (ARC Fellowship)  
 Chris Glover, BSc Newcastle, PhD ANU (ARC Fellowship)  
 Patrick Kluth, PhD Julich (Humboldt Fellowship)  
 Susan Kluth, BSc BEng PhD Leuven (ARC Fellowship)  
 Tessica Weijers, BSc QUT, PhD ANU (ARC Fellowship) (from October)

**Visiting Fellows**

Stuart Campbell, BSc Aberd, MSc Salf, PhD Mon, FAIP  
 Neville Fletcher, PhD Harv, DSc Syd, FIP, FAIP, FAAS, FTSE, FAA, AM  
 Jeff McCullam, BSc PhD Melbourne  
 Michael Swain, BSc PhD UNSW (from December)  
 Heiko Timmers, Dipl Phys Munich, PhD ANU  
 Peter Zory, BSc Syracuse, PhD Carnegie-Mellon (January to February)  
 Tessica Weijers, PhD ANU (until October)

**Research Assistants**

David Llewellyn (jointly with Electron Microscopy Unit, RSBS)  
 Jun Yu (Assistant to Ying Chen)  
 Bettina Wolpensinger (Assistant to Robert Elliman, Ying Chen and Jim Williams)

**Head Technical Officer**

Tom Halstead, ElectCommCert Canb TAFE

**Senior Technical Officers**

Michael Aggett, AssocDipMechEng CIT  
 Bernie King, ONC UK  
 Fred Johnson

**Laboratory Technicians**

Martin Conway

**Departmental Administrator**

Renee Vercoe

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Chen, Y., Conway, M.J. and Fitzgerald, J.D.# *Carbon Nanotubes Formed in Graphite After Ball Milling and Annealing* Applied Physics A: Materials Science and Processing 76 (2003) 633-636

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## Department Publications

Legend: \* External to the University, # Member of another area of this University other than this School, † Author having a joint appointment across departments within the School

**Publications in Refereed Journals**

Azevedo, G.M. de, Glover, C.J.\*, Ridgway, M.C., Yu, K.M.\* and Foran, G.J.\* *Direct Evidence of Defect Annihilation During Structural Relaxation of Amorphous Indium Phosphide* Physical Review B 68 (2003) 115204-1-6



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Physica B: Physics of Condensed Matter 340-342 (2003) 315-319
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Professor Barry Luther-Davies

# Laser Physics Centre

*The Laser Physics Centre is engaged in laser-based research on topics spanning fundamental and applied physics and engineering.*

Research within the Centre covers many of the most exciting aspects of contemporary laser-based research. The activities within the Centre can be broadly divided into seven areas: laser matter interactions, nonlinear optical phenomena, nonlinear optical materials, solid state spectroscopy, UV spectroscopy, atom manipulation, and photonics. Research in photonics is partly supported by the Australian Photonics Cooperative Research Centre. Research highlights for 2003 include the first demonstration of two-qubit quantum logic operations in solid state impurity sites (Longdell, Sellars, Manson); the successful demonstration of femtosecond laser writing and reading of 3D optical memory involving collaboration with Professors Mizawa and Juodkazis from Tokushima University (Gamaly, Rode); the successful completion of a 50 W mode-locked laser system for ultrafast laser deposition involving collaboration with Malte During and Joachim Giesekeus from Fraunhofer ILT in Aachen (Kolev, Luther-Davies); and demonstration of the production of optically-induced lattices in nonlinear optical materials (Krolikowski, Neshev); and development of a low chirp (<10 MHz), Fourier transform-limited, long pulse (25 ns) optical parametric oscillator for high resolution spectroscopy (Baldwin, Orr).

2003 was a good year for new competitive funding. Activities started within the two new Centres of Excellence funded by the Australian Research Council announced at the end of 2002. We play a major role in the Centre for Ultra-high Bandwidth Devices for Optical Systems (CUDOS) which brings around \$800K of additional funding each year to activities in the School. CUDOS involves collaboration with groups at the University of Sydney, The University of Technology, Sydney, Macquarie University, Swinburne University and the CSIRO and aims to develop new all-optical technologies for advanced photonic "chips". We have a smaller involvement in the Australian Centre for Quantum-Atom Optics, (ACQAO) whose partners are the University of Queensland and Swinburne University. ACQAO focuses on fundamental research, but has a long-term goal to underpin and develop the next generation quantum technology.

A number of other ARC grants were won during the year. Barry Luther-Davies was awarded a prestigious Federation Fellowship commencing in October.

This fellowship is for the creation of novel photonic and nano-structured materials by ablation of solids with ultra-fast lasers. Work started on two Discovery grants awarded in 2002, the storage of non-classical light, and the development of a quantum computer. Two new ARC Discovery grants were won in the 2003 round for work on integrated magneto-optic devices (Jarvis, Luther-Davies) and solitons in non-local media (Krolikowski). An ARC Linkage grant to develop a sodium laser guide star in collaboration with Electro Optic Systems Pty Ltd of Queanbeyan was also received (Kolev, Luther-Davies). Ken Baldwin was Initiative Coordinator on a successful bid for an ARC Special Research Initiatives Seed Funding Grant for the "Network for Optical and Quantum Science and Technology". Several members of staff continue to work as consultants at RPO Pty Ltd whose activities stemmed from work on inorganic polymer glasses funded by the Australian Photonics CRC, and a new contract was signed with the company during 2003.

The Centre congratulates Wieslaw Krolikowski on his promotion to Professor and Matt Sellars on his promotion to academic level C. Congratulations also go to Snjezana Tonljenovic-Hanic and Jevon Longell who were awarded their PhDs during the year. We were pleased to welcome new students Annabel Alexander, Brendon Hanna, Darren Freeman, Nathan Madsen, Roger McMurtrie and Khu Vu. Jochen Schröder and Malte During spend lengthy periods in the Centre as visiting scholars.

## Centre Staff

### Professor and Head of Department

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

### Professor

Neil Manson, MSc PhD Aberd

### Senior Fellows

Ken Baldwin, MSc ANU, DIC PhD Lond, FAIP, FOSA (joint project with Atomic and Molecular Physics Laboratories)

Wieslaw Krolikowski, MSc PhD Wars

Andrei Rode, MSc PhD Mosc  
Marek Samoc, PhD DSc Wroc

#### Fellows

Anna Samoc, MSc PhD Wroc

#### Research Fellow

Matthew Sellars, BSc PhD ANU

#### Postdoctoral Fellows

Ruth Jarvis, BE BSc ANU (Australian Photonics CRC)

Douglas Bulla, MSc PhD USP Brazil (Australian Photonics CRC)

Weitang Li, MSc China,

PhD Sydney

(Australian Photonics CRC)

Congji Zha, BE Jingdezhen, ME WUT, PhD Sydney

(from September)

#### Visiting Fellows

Graham Atkins, BSc PhD Sydney

Robbie Charters, BSc Nott, PhD Cranfield

Ben Cornish, BSc ANU

Eugene Gamaly, PhD DSc Mosc (from August) (jointly with AM)

Graeme Gordon

Mark Humphrey, BSc PhD Adelaide (until September)

Dax Kukulj, BSc PhD UNSW (until May and from October)

Jevon Longdell, BSc Waikatao, MSc Auck, PhD ANU (from December)

David Pulford, BSc PhD

John Wyller, MSc PhD Tromsø (jointly with DU) (from August)

Congji Zha, BE Jingdezheng, ME WUT, PhD Syd  
(until August)

Guo Zhen, PhD Shanghai

#### Research Assistants

Mr Vesselin Kolev, Eng-Phys Uni of Plovdiv

Mr Darren Freeman, BEng (EE) (Hons) Flinders

#### Head Technical Officer

Ian McRae

#### Senior Technical Officers

Craig Macleod, AssocDipMechEng CIT

Mike Pennington, AssocDipAppSci&Inst CIT

Anita Smith, BSc Flinders

#### Technical Officers

John Bottega

Maryla Krolikowska

#### Departmental Administrators

Sharon Lopez (to May)

Belinda Barbour

## Centre Publications

Legend: \* External to the University, # Member of another area of this University other than this School, † Author having a joint appointment across departments within the School

#### Publications in Refereed Journals

Chan, A.\*<sup>‡</sup>, Rode, A.V., Gamaly, E.G.<sup>†</sup>, Luther-Davies, B., Taylor, B.\*<sup>‡</sup>, Dawes, J.\*<sup>‡</sup>, Lowe, M.\*<sup>‡</sup> and Hannaford, P.\*<sup>‡</sup>  
*Ablation of Dental Enamel Using Subpicosecond Pulsed Lasers*  
International Congress Series 1248 (2003) 117-119

Choudhury, K.R.\*<sup>‡</sup>, Winiarz, J.G.\*<sup>‡</sup>, Samoc, M. and Prasad, P.N.\*<sup>‡</sup>  
*Charge Carrier Mobility in an Organic-inorganic Hybrid Nanocomposite*  
Applied Physics Letters 82 (2003) 406-408

Cruz, S.A.\*<sup>‡</sup>, Gamaly, E.G.<sup>†</sup>, Chadderton, L.T. and Fink, D.\*<sup>‡</sup>  
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Radiation Measurements 36 (2003) 145-149

Feliz, M.\*<sup>‡</sup>, Llusar, R.\*<sup>‡</sup>, Uriel, S.\*<sup>‡</sup>, Vicent, C.\*<sup>‡</sup>, Humphrey, M.G.#, Lucas, N.T.#, Samoc, M. and Luther-Davies, B.  
*Solid State Synthesis, Structure and Optical Limiting Properties of Seleno Cuboidal Clusters [M3Se4X3(diphosphine)3]+(M=Mo,W,X=Cl, Br)*  
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Garriga, J.M.\*<sup>‡</sup>, Llusar, R.\*<sup>‡</sup>, Uriel, S.\*<sup>‡</sup>, Vicent, C.\*<sup>‡</sup>, Usher, A.J.#, Lucas, N.T.#, Humphrey, M.G.# and Samoc, M.  
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Golberg, D.\*<sup>‡</sup>, Rode, A.V., Bando, Y.\*<sup>‡</sup>, Mitome, M.\*<sup>‡</sup>, Gamaly, E.G.<sup>†</sup> and Luther-Davies, B.  
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Optics Communications 224 (2003) 89-95

Hurst, S.K.#, Lucas, N.T.#, Humphrey, M.G.#, Isoshima, T.\*<sup>‡</sup>, Wostyn, K.\*<sup>‡</sup>, Asselberghs, I.\*<sup>‡</sup>, Clays, K.\*<sup>‡</sup>, Persoons, A.\*<sup>‡</sup>, Samoc, M. and Luther-Davies, B.  
*Organometallic Complexes for Nonlinear Optics. Part 29. Quadratic and Cubic Hyperpolarizabilities of Stilbenylethynyl-gold and -ruthenium Complexes*  
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Hurst, S.K.#, Humphrey, M.G.#, Morrall, J.P.#, Cifuentes, M.P.#, Samoc, M., Luther-Davies, B., Heath, G.W.# and Willis, A.C.#  
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Kono, M., Lewis, B.R., Baldwin, K.G.H.<sup>†</sup> and Gibson, S.T.  
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- Powell, C.E.<sup>#</sup>, Humphrey, M.G.<sup>#</sup>, Cifuentes, M.P.<sup>#</sup>, Morrall, J.P.<sup>#</sup>, Samoc, M. and Luther-Davies, B.  
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*A Comparative Schlieren Imaging Study Between ns and Sub-ps Laser Forward Transfer of Cr*  
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*Geometry Effects upon the Transmission Loss in Optical Rib Waveguides Fabricated Using Chemical Etching*  
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- Luo, X., Zha, C. and Luther-Davies, B.  
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- Luo, X., Zha, C. and Luther-Davies, B.  
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- Luther-Davies, B., Kolev, V.Z., Lederer, M.J., Yinlan, R., Samoc, M., Jarvis, R., Rode, A.V., Gieseckus, J.\*<sup>\*</sup>, Du, K.-M.\*<sup>\*</sup>, Duering, M.\*<sup>\*</sup> and Zakery, N.\*<sup>\*</sup>  
*Low Loss Chalcogenide Glass Waveguides Produced by Pulsed Laser Deposition*  
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- Luther-Davies, B., Kolev, V.Z., Lederer, M.J., Ruan, Y., Samoc, M., Jarvis, R., Rode, A.V., Gieseckus, J.\*<sup>\*</sup>, Du, K.-M.\*<sup>\*</sup> and Duering, M.\*<sup>\*</sup>  
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- McCarthy, G., Breuninger, T., Schröder, J.\*, Denz, C.\*, Neshev, D. and Krolikowski, W.  
*Spatial-soliton Interactions: Experiment versus Theory*  
COIN/ACOFT 2003, Melbourne (2003) 205-208
- Neshev, D., Ostrovskaya, E.A., Kivshar, Yu.S. and Krolikowski, W.  
*Localization of Light in Optically-induced Gratings*  
CLEO/QELS 2003, Baltimore, USA (2003) QThk6-1-2
- Sukhorukov, A.A., Neshev, D., Kivshar, Yu.S. and Krolikowski, W.  
*Nonlinear Bloch-wave Spectroscopy of Optically-induced Gratings*  
CLEO/QELS 2003, Baltimore, USA (2003) CMH1-1-2
- Uhlmann, L.J., Dall, R.G., Swansson, J.A., Leung, V., Hoogerland, M.D., Truscott, A.G., Baldwin, K.G.H.<sup>†</sup> and Buckman, S.J.  
*A Laser Cooled Metastable Helium Facility for Atomic Collision Research*  
21st Summer School and International Symposium on the Physics of Ionized Gases (21st SPIG), Sokobanja, Yugoslavia (2003) 19-33
- Zergioti, I.\*<sup>\*</sup>, Papazoglou, D.G.\*<sup>\*</sup>, Gamaly, E.G.<sup>†</sup>, Rode, A.V. and Fotakis, C.\*<sup>\*</sup>  
*Studies on Ultra-short Laser Micro Structuring*  
Advanced Optical Processing of Materials Symposium, San Francisco, USA (2003)



# Nonlinear Physics Centre

*The Nonlinear Physics Centre is engaged in fundamental research on nonlinear phenomena and the dynamics of nonlinear localised waves and solitons in different branches of physics.*

*Professor Yuri Kivshar*

The interdisciplinary research of the Centre covers several topics such as nonlinear optics and all-optical switching devices, nano-optics and photonic crystals, self-trapping effects and energy transfer in condensed matter physics and biopolymers, nonlinear atom optics and dynamics of Bose-Einstein condensates, and more recently, linear and nonlinear effects in left-handed metamaterials. Other research covered is linear and nonlinear optics, quantum optics, parametric effects and frequency conversion, dissipative solitons, nonlinear materials, etc.

Research highlights for 2003 include the demonstration of the production of optically-induced lattices in nonlinear optical materials (Neshev); the first experimental generation of discrete vortices (Neshev, Alexander, Ostrovskaya and Kivshar); experimental and theoretical studies of spatial gap solitons in optically-induced lattices (Sukhorukov, Neshev, Krolikowski and Kivshar); the first prediction of gap vortices in optical lattices (Ostrovskaya); the development of the comprehensive theory of nonlinear effects in left-handed materials (Shadrivov and Kivshar); the theoretical demonstration of giant Lamb shift in photonic crystals (Wang); and the theory of nonlinear switching in periodic structures with negative refraction (Feise and Shadrivov). Added to our important milestones for 2003 was the publication of a book on optical solitons (Agrawal and Kivshar) and a comprehensive review paper on parametric processes for Progress in Optics (Saltiel, Sukhorukov and Kivshar). Overall, in 2003 the members of the Group published seven papers in Physical Review Letters, the top-ranked journal in physics, the largest number ever published annually by a single department in the School.

This was a good year for new competitive funding. Our major activities are supported by the two new Centres of Excellence funded by the Australian Research Council announced at the end of 2002. We play a major role in the Centre for Ultra-high Bandwidth Devices for Optical Systems (CUDOS) which brings around \$800K of additional funding each year to activities in the School. We also have a strong involvement in the Australian Centre for Quantum-Atom Optics, (ACQAO). In view of our earlier success with the ARC funding, we have had limited eligibility to apply for new funding from the ARC. Nevertheless, a new ARC Discovery grant (\$750K) was won in the 2003 round for work on optically-induced lattices (Neshev, Sukhorukov).

The Centre congratulates both Andrey Sukhorukov and Elena Ostrovskaya on their promotion to level B. Congratulations also go to Tristram Alexander who submitted his thesis in 2003 and has already been awarded his PhD this year. We were pleased to

welcome new PhD student Beata Dabrowska. During 2003, the Group hosted a number of visiting scholars and visiting fellows, including Alex Zharov (Russia), Solomon Saltiel (Bulgaria), John Wyller (Norway), Dmitry Pelinovsky (Canada), Jean Guy Caputo (France), Nina Zharova (Russia), Jose Salgueiro (Spain) and Kristian Motzek (Germany).

## Centre Staff

### Professor and Head of Centre

Yuri Kivshar, PhD USSR Acad Sci

### Professor

Solomon Saltiel, MSc PhD Mosc, DSc Sofia (from June)

### Research Fellows

Michael Feise, MSc PhD Pullman

Dragomir Neshev, MSc PhD Sofia

Elena Ostrovskaya, MSc Mosc, PhD ANU

Xue-Hua Wang, PhD China

### Postdoctoral Fellows

Tristram Alexander PhD ANU (from August)

Andrey Sukhorukov, PhD ANU

### Visiting Fellows

Jean Caputo, MSc PhD Grenoble (June to August)

Dmitry Pelinovsky, MSc PhD Monash

Sergei Kun, MSc PhD Kiev (jointly with TP) (from June)

Kristian Motzek, MSc Darmstadt (October to December)

Jose Ramon Salgueiro, MS PhD Santiago de Compostela

John Wyller, MSc PhD Tromsø (jointly with LPC)(from August)

Alexander Zharov, BSc Gorky, PhD USSR AcadSci, DSc NIRFI, Russia (February to April, October to December)

Nina Zharova, BSc Gorky, PhD USSR AcadSci (Oct. to December)

### Departmental Administrator

Wendy Quinn, BA

## Centre Publications

### Books and Book Chapters

Kivshar, Yu.S. and Agrawal, G.P.\*  
**Optical Solitons from Fibers to Photonic Crystals**  
Academic Press, USA (2003) 540pp

Mingaleev, S.F. and Kivshar, Yu.S.  
*Nonlinear Localized Modes in 2D Photonic Crystals and Waveguides*  
in *Nonlinear Photonic Crystals*, Springer-Verlag,  
Germany (2003) 351-369

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Branki, F.\*, Neshev, D. and Ubachs, W.\*  
*High-order Harmonic Generation Yielding Tunable Extreme-ultraviolet  
Radiation of High Spectral Purity*  
*Physical Review Letters* 91 (2003) 163901-1-4

Crasovan, L.-C.\*, Kartashov, Y.V.\*, Mihalache, D.\*, Torner, L.\*, Kivshar, Yu.S.  
and Perez-Garcia, V.M.\*  
*Soliton "Molecules": Robust Clusters of Spatiotemporal Optical Solitons*  
*Physical Review E* 67 (2003) 046610-1-5

Desyatnikov, A.S., Ostrovskaya, E.A., Kivshar, Yu.S. and Denz, C.\*  
*Composite Band-gap Solitons in Nonlinear Optically Induced Lattices*  
*Physical Review Letters* 91 (2003) 153902-1-4

Kevrekidis, P.G.\*, Kivshar, Yu.S. and Kovalev, A.S.\*  
*Instabilities and Bifurcations of Nonlinear Impurity Modes*  
*Physical Review E* 67 (2003) 046604-1-8

Kivshar, Yu.S. and Flach, S.\*  
*Nonlinear Localized Modes*  
*Chaos: An Interdisciplinary Journal of Nonlinear Science* 13 (2003)  
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Kivshar, Yu.S., Kevrekidis, P.G.\* and Takeno, S.\*  
*Nonlinear Localized Modes in Waveguide Bends*  
*Physics Letters A* 307 (2003) 287-291

Krolikowski, W., McCarthy, G., Kivshar, Yu.S., Weillnau, C.\*, Denz, C.\*, Garcia-  
Ripoll, J.\* and Perez-Garcia, V.M.\*  
*Scattering of Dipole-mode Vector Solitons: Theory and Experiment*  
*Physical Review E* 68 (2003) 016612-1-8

Louis, P.J.Y., Ostrovskaya, E.A., Savage, C.\* and Kivshar, Yu.S.  
*Bose-Einstein Condensates in Optical Lattices: Band-gap Structure and  
Solitons*  
*Physical Review A* 67 (2003) 013602-1-9

McCarthy, G., Breuninger, T., Schröder, J.\*, Denz, C.\*, Neshev, D. and  
Krolikowski, W.  
*Mutual Spatial-soliton Trapping in Photorefractive Media: Experiment  
Versus Theory*  
*Applied Physics B Lasers and Optics* 77 (2003) 421-426

Neshev, D., Ostrovskaya, E.A., Kivshar, Yu.S. and Krolikowski, W.  
*Spatial Solitons in Optically Induced Gratings*  
*Optics Letters* 28 (2003) 710-712

Nikolov, N.I., Neshev, D., Bang, O.\* and Krolikowski, W.  
*Quadratic Solitons as Nonlocal Solitons*  
*Physical Review E* 68 (2003) 036614-1-5

Ostrovskaya, E.A. and Kivshar, Yu.S.  
*Matter-wave Gap Solitons in Atomic Band-gap Structures*  
*Physical Review Letters* 90 (2003) 160407-1-4

Qi, W.\*, Kun, S.Yu. †, Wendong, T.\*, Songlin, L.\*, Zhonghe, J.\*, Yuchuan, D.\*,  
Zhichang, L.\*, Xiuqin, L.\*, Kui, Z.\*, Changbo, F.\*, Jiancheng, L.\*, Hua, J.\*,  
Guiqing, H.\* and Greiner, W.\*  
*Experimental Test of Spontaneous Correlation and Anomalous Sensitivity  
in Finite Highly Excited Many-body Systems*  
*International Journal of Modern Physics E - Nuclear Physics* 12 (2003)  
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Salgueiro, J.R., Sukhorukov, A.A., Kivshar, Yu.S. and Saltiel, S.M.\*  
*Parametric Vector Solitons in Tetragonal Crystals*  
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Salgueiro, J.R., Sukhorukov, A.A. and Kivshar, Yu.S.  
*Spatial Optical Solitons Supported by Mutual Focusing*  
*Optics Letters* 28 (2003) 1457-1459

Shadrivov, I.V., Sukhorukov, A.A. and Kivshar, Yu.S.  
*Beam Shaping by a Periodic Structure with Negative Refraction*  
*Applied Physics Letters* 82 (2003) 3820-3822

Shadrivov, I.V., Zharov, A.A. and Kivshar, Yu.S.  
*Giant Goos-Hanchen Effect at the Reflection from Left-handed  
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*Applied Physics Letters* 83 (2003) 2713-2715

Shadrivov, I.V., Sukhorukov, A.A. and Kivshar, Yu.S.  
*Guided Modes in Negative-refractive-index Waveguides*  
*Physical Review E* 67 (2003) 057602-1-3

Shadrivov, I.V. and Zharov, A.A.  
*Interaction of Vector Solitons with a Nonlinear Interface*  
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Sukhorukov, A.A. and Kivshar, Yu.S.  
*Generation and Stability of Discrete Gap Solitons*  
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Sukhorukov, A.A. and Kivshar, Yu.S.  
*Multigap Discrete Vector Solitons*  
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Sukhorukov, A.A. and Akhmediev, N.N.  
*Multipoint Soliton Devices with Controllable Transmission*  
*Optics Letters* 28 (2003) 908-910

Sukhorukov, A.A., Kivshar, Yu.S., Eisenberg, H.S.\* and Silberberg, Y.\*  
*Spatial Optical Solitons in Waveguide Arrays*  
*IEEE Journal of Quantum Electronics* 39 (2003) 31-50

Theocharis, G.\*, Frantzeskakis, D.J.\*, Kevrekidis, P.G.\*, Malomed, B.A.\* and  
Kivshar, Yu.S.  
*Ring Dark Solitons and Vortex Necklaces in Bose-Einstein Condensates*  
*Physical Review Letters* 90 (2003) 120403-1-4

Vinencio, R.A.\*, Molina, M.I.\* and Kivshar, Yu.S.  
*Controlled Switching of Discrete Solitons in Waveguide Arrays*  
*Optics Letters* 28 (2003) 1942-1944

Zharov, A.A., Shadrivov, I.V. and Kivshar, Yu.S.  
*Nonlinear Properties of Left-handed Metamaterials*  
*Physical Review Letters* 91 (2003) 037401-1-4

#### Refereed Conference Proceedings

Desyanikov, A.M.\*, Denz, C.\* and Kivshar, Yu.S.  
*Composite Bound States of Spatial Optical Solitons*  
CLEO/Europe - EQEC 2003, Munich, Germany (2003) EE5-4-THU

Kivshar, Yu.S. and Mingaleev, S.F.  
*Nonlinear Photonic Crystals:  
All-optical Switching and Gap Solitons*  
IEEE LEOS Summer Topical Meeting, Vancouver, Canada (2003) 21-22

Kivshar, Yu.S.  
*Nonlinear Photonic Crystals*  
87th OSA Annual Meeting, Tucson, USA (2003) MF1-1

Louis, P.J.Y., Ostrovskaya, E.A., Kivshar, Yu.S. and Savage, C.\*  
*Bose-Einstein Condensates in One-dimensional Optical Lattices: Bandgap  
Structure and Solitons*  
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Shadrivov, I.V., Sukhorukov, A.A. and Kivshar, Yu.S.  
*Guided Modes in Negative Refractive Index Waveguides*  
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Shadrivov, I.V., Sukhorukov, A.A., Kivshar, Yu.S., Boardman, A.D.\* and Zharov,  
A.A.\*  
*Surface Polaritons of Nonlinear Left-handed Materials*  
CLEO/Europe - EQEC 2003, Munich, Germany (2003) EB2-6-Mon

Sukhorukov, A.A. and Kivshar, Yu.S.  
*Controlled Generation and Steering of Spatial Gap Solitons in Waveguide  
Arrays*  
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Sukhorukov, A.A., Neshev, D., Kivshar, Yu.S. and Krolikowski, W.  
*Nonlinear Bloch-wave Spectroscopy of Optically-induced Gratings*  
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Sukhorukov, A.A. and Kivshar, Yu.S.  
*Stability and Excitation of Gap Solitons in Binary Waveguide Arrays*  
CLEO/QELS 2003, Baltimore, USA (2003) QWA23-1-2



Professor George Dracoulis

# Nuclear Physics

*The Department operates the premier laboratory in Australia for accelerator-based research in nuclear physics, providing and developing facilities for local staff and national and international outside users. The facilities are used for postgraduate and postdoctoral training over a wide range of research, from basic to applied.*

The Department had a productive year in terms of both the research carried out by staff and in the development and operation of the Heavy Ion Accelerator Facility, the premier laboratory in Australia for accelerator-based research in nuclear physics, providing and developing facilities for local staff and national and international outside users

Approximately 40 papers were published in major peer-reviewed journals and Department members contributed to about 20 conferences and workshops, 14 of them international, including nine invited papers.

Research highlights range from basic research in nuclear structure to climate change. The successful observation of linking transitions connecting the superdeformed structures to normal states in the neutron-deficient nucleus Pb-192 by a local team led by Anna Wilson and including collaborators at the Lawrence Berkeley National Laboratory has led to renewed interest in tunneling in nuclear systems. In contrast, the application of Accelerator Mass Spectrometry dating techniques to the extraction of the history of Ice Age glaciers in Australia has provided new information on historical mean temperatures with profound implications for the adaptation to such conditions and subsequent changes by Australian Aborigines.

External funding was obtained to support the main areas of research including the following ARC Discovery grants: "Characterising Nuclei Far From Stability with a Novel Recoil Spectrometer (2004-2006)" (Dracoulis, Lane and Kibedi); "Development of Advanced Detection Systems for Accelerator Mass Spectrometry" (Mortona) and "Superdeformed Nuclei and their Decay" (Wilson).

The Department was also successful in obtaining a major ARC LIEF grant with the support of collaborators from the Department of Electronic Materials Engineering, the Department of Physics in the Faculties, Macquarie University, the University of Newcastle and the University of New South Wales. The main objectives of the proposal entitled "National Heavy Ion Accelerator" are to enhance the capabilities of the Heavy Ion Facility by extending both the energy range and the range of beam species. The variety of beams provided by the facility are already used for an extensive range of research in basic science, applications and research training. In 2003 alone there were nearly 50 international users of the facility including 18 postgraduate students

Awards this year include the 2003 Lyle Medal, a senior award of the Australian Academy of Science, to George Dracoulis. The award recognised both his individual contributions to nuclear structure and the international standing of the laboratory. Annette Berriman won the 2002 Australian Institute Bragg Gold Medal for her PhD thesis on "Entrance-Channel Effects in Fission-Fusion Dynamics", and Centenary Medals were awarded to George Dracoulis and John Newton.

Greg Lane was promoted to level C, Tim Barrows to level B and both David Hinde and Aidan Byrne were promoted to Professor.

## Department Staff

### Professor and Head of Department

George Dracoulis, BSc PhD Melb, FAIP, FAPS, Hon. FRSNZ, FAA

### Senior Fellows

Tezer Esat, MSc Queens, PhD ANU (jointly with Research School of Earth Sciences)

David Hinde, BSc Manc, PhD ANU, FAIP

Keith Fifield, MSc Auck, PhD Penn, FAIP

Andrew Stuchbery, BSc PhD Melb, FAIP

### Reader

Aidan Byrne, MSc Auck, PhD ANU, FAIP

(jointly with Department of Physics, The Faculties)

### Fellow

Mahananda Dasgupta, BSc MSc Rajasthan, PhD Bombay (from June; ARC QEII Fellowship until June)

Tibor Kibédi, PhD Debrecen

### Research Fellows

Greg Lane, BSc PhD ANU (ARC Fellowship)

Stephen Tims, BSc PhD Melb

Anna Wilson, BSc Bristol, PhD Liverpool



**Post Doctoral Fellows**

Timothy Barrows, BSc PhD ANU

Clyde Morton, BSc Sydney, PhD ANU (ARC Fellowship)

**Visiting Fellows**

Bruce Barrett, BSc Kansas, MSc PhD Stanford (May to June)

Igor Gontchar, Dip Omsk, PhD Tomsk, DSc Dubna (July to September)

John Newton, MA PhD Camb, DSc Manc, FAA (Emeritus Professor)

Susanne Olivier, Dipl Chem Berne (until March)

Ray Spear, PhD DSc Melb, FAPS, FAIP (Emeritus Professor)

Martin Suter, PhD ETH, Zurich (July to August)

Heiko Timmers, Dipl Phys Munich, PhD

ANU

(jointly with EME)

Katrien Vyvey, BSc MSc PhD Leuven (January to July)

**Accelerator Research and Operations Manager**

David Weisser, MSc PhD Minn, FAIP

**Engineer**

Nikolai Lobanov, BSc Moscow, PhD St Petersburg

**Research Officers**

Paul Davidson, BSc MSc Auck, PhD ANU

Gordon Foote, BSc Lond, PhD ANU

Vladimir Levchenko, MSc PhD St Petersburg

**Technical Officers**

John Bockwinkel, AssocDipMechEng

Alan Cooper, AssocDipMechEng

Alan Harding

Justin Heighway, AssocDipAppSci

John Kennedy

Lorenzo Lariosa

Alistair Muirhead

Andy Rawlinson (June to August)

Bob Turkentine

Howard Wallace

**Departmental Administrator**

Marj O'Neill

**Department Publications**

Legend: \* External to the University, # Member of another area of this University other than this School, † Author having a joint appointment across departments within the School

**Books and Book Chapters**

Dracoulis, G.D., Byrne, A.P., Lane, G.J., Baxter, A.M.#, Kibédi, T., Macchiavelli, A.O.\*, Fallon, P.\* and Clark, R.M.\*

*Isomers and E0 Transitions as a Probe of Triple Shape Co-existence in <sup>188</sup>Pb*  
in *Frontiers of Nuclear Structure*, American Institute of Physics, USA (2003) 47-54

Hartley, D.J.\*, Djongolov, M.\*, Riedinger, L.L.\*, Kondev, F.G.\*, Janssens, R.V.F.\*, Abu Saleem, K.\*, Ahmed, I.\*, Balabanski, D.L.\*, Carpenter, M.P.\*, Chowdhury, P.\*, Cullen, D.M.\*, Danchev, M.\*, Dracoulis, G.D., El-Masri, H.\*, Goon, J.\*, Heinz, A.\*, Kaye, R.A.\*, Khoo, T.L.\*, Lauritsen, T.\*, Lister, C.J.\*, Moore, E.F.\*, Riley, M.A.\*, Seweryniak, D.\*, Shestakova, I.\*, Sletten, G.\*, Walker, P.M.\*, Wheldon, C.\*, Wiedenhöver, I.\*, Zeidan, O.\* and Zhang, J.-Y.\*

*Possible Triaxial Superdeformation in <sup>174</sup>Hf*  
in *Frontiers of Nuclear Structure*, American Institute of Physics, USA (2003) 177-183

Lane, G.J., Byrne, A.P. and Dracoulis, G.D.

*High-spin Isomers, Residual Interactions and Octupole Correlations in the N=128 Isotones: <sup>211</sup>Bi, <sup>212</sup>Po and <sup>213</sup>At*  
in *Frontiers of Nuclear Structure*, American Institute of Physics, USA (2003) 386-393

**Publications in Refereed Journals**

Bark, R.A., Baxter, A.M.#, Byrne, A.P., Davidson, P.M., Dracoulis, G.D., Mullins, S.M., McGoram, T.R. and Newman, R.

*Two-quasiparticle Configurations, Signature Inversion and the  $\pi$ 13/2 x  $\nu$ 13/2 Band in <sup>176</sup>Ir*  
*Physical Review C: Nuclear Physics* 67 (2003) 014320-1-14

Bertulani, C.A.\*, Stuchbery, A.E., Mertzimekis, T.J.\* and Davies, A.D.\*  
*Intermediate Energy Coulomb Excitation as a Probe of Nuclear Structure at Radioactive Beam Facilities*

*Physical Review C: Nuclear Physics* 68 (2003) 044609-1-10

Bird, M.I.#, Fifield, L.K., dos Santos, G.M., Beaumont, P.B.\*, Zhou, Y.#, di Tada, M.L. and Hausladen, P.A.

*Radiocarbon Dating from 40 to 60 ka BP at Border Cave, South Africa*  
*Quaternary Science Reviews* 22 (2003) 943-947

Bird, M.I.#, Turney, C.S.M.#, Fifield, L.K., Smith, M.A.\*, Miller, G.H.\*, Roberts, R. and Magee, J.W.#

*Radiocarbon Dating of Organic- and Carbonate-carbon in Genyornis and Dromaius Eggshell Using Stepped Combustion and Stepped Acidification*  
*Quaternary Science Reviews* 22 (2003) 1805-1812

Byrne, A.P., Lane, G.J. and Dracoulis, G.D.

*Residual Interactions and High Spin States in A=211 Isobars*  
*Acta Physica Polonica B* 34 (2003) 2285-2294

Cabrera, J.\*, Keutgen, Th.\*, El Masri, Y.\*, Dufauquez, Ch.\*, Roberfroid, V.\*, Tilquin, I.\*, Van Mol, J.\*, Régimbart, R.\*, Charity, R.J.\*, Natowitz, J.B.\*, Hagel, K.\*, Wada, R.\* and Hinde, D.J.

*Fusion-fission and Fusion-evaporation Processes in <sup>20</sup>Ne+<sup>159</sup>Tb and <sup>20</sup>Ne+<sup>169</sup>Tm Interactions Between E/A=8 and 16 MeV*  
*Physical Review C: Nuclear Physics* 68 (2003) 034613-1-21

Cullen, D.M.\*, Pattison, L.K.\*, Smith, J.F.\*, Fletcher, A.M.\*, Walker, P.M.\*, El-Masri, H.M.\*, Podolyak, Z.S.\*, Wood, R.J.\*, Scholey, C.\*, Wheldon, C.\*, Mukherjee, G.\*, Balabanski, D.\*, Djongolov, M.\*, Dalsgaard, Th.\*, Thisgaard, H.\*, Sletten, G.\*, Kondev, F.\*, Jenkins, D.\*, Dracoulis, G.D., Lane, G.J., Lee, I.-Y.\*, Macchiavelli, A.O.\* and Xu, F.\*

*High-spin States, Lifetime Measurements and Isomers in <sup>181</sup>Os*  
*Nuclear Physics A* 728 (2003) 287-338

Dasgupta, M., Hinde, D.J. and Hagino, K.\*

*Insights into the Influence of Breakup on Fusion Through Reactions with Weakly Bound Stable Nuclei*  
*Nuclear Physics A* 722 (2003) 196c-201c

Djongolov, M.\*, Hartley, D.J.\*, Riedinger, L.L.\*, Kondev, F.G.\*, Janssens, R.V.F.\*, Abu Saleem, K.\*, Ahmad, I.\*, Balabanski, D.L.\*, Carpenter, M.P.\*, Chowdhury, P.\*, Cullen, D.M.\*, Danchev, M.\*, Dracoulis, G.D., El-Masri, H.\*, Goon, J.\*, Heinz, A.\*, Kaye, R.\*, Khoo, T.L.\*, Lauritsen, T.\*, Lister, C.J.\*, Moore, E.F.\*, Riley, M.A.\*, Seweryniak, D.\*, Shestakova, I.\*, Sletten, G.\*

- Walker, P.M.\*, Wheldon, C.\*, Wiedenhöver, I.\*, Zeidan, O.\* and Zhang, J.-Y.\*  
*Extending the Region of Triaxial Superdeformation: Candidate TSD Bands in 174Hf*  
 Physics Letters B 560 (2003) 24-30
- dos Santos, G.M., Bird, M.I.#, Parenti, F.\*, Fifield, L.K., Guidon, N.\* and Hausladen, P.A.  
*A Revised Chronology of the Lowest Occupation Layer of Pedra Furada Rock Shelter, Piauí, Brazil; the Pleistocene Peopling of the Americas*  
 Quaternary Science Reviews 22 (2003) 2303-2310
- Dracoulis, G.D., Lane, G.J., Byrne, A.P., Baxter, A.M.#, Kibédi, T., Macchiavelli, A.O.\*, Fallon, P.\* and Clark, R.M.\*  
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*Spin Polarization of 37K Produced in a Single-proton Pickup Reaction at Intermediate Energies*  
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*Exploratory Studies Towards Fusion with the 16+ Isomer of 178Hf*  
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- Mertzimekis, T.J.\*, Stuchbery, A.E., Benczer-Koller, N.\* and Taylor, M.J.\*  
*Systematics of First 2+ State g Factors Around Mass 80*  
 Physical Review C: Nuclear Physics 68 (2003) 054304-1-9
- Moon, C.B.\*, Dracoulis, G.D., Bark, R.A., Byrne, A.P., Davidson, P.M., Wilson, A.N., Baxter, A.M.#, Kibédi, T. and Lane, G.J.  
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*Interplay Between K-Isomerism and  $\tilde{\alpha}$ -Softness in 128Xe*  
 Acta Physica Polonica B 34 (2003) 2253-2256
- Podolyák, Zs.\*, Walker, P.M.\*, Mach, H.\*, de France, G.\*, Sletten, G.\*, Azaiez, F.\*, Casandjian, J.M.\*, Cederwall, B.\*, Cullen, D.M.\*, Dombrádi, Zs.\*, Dracoulis, G.D., Fraile, L.M.\*, Franchoo, S.\*, Fynbo, H.\*, Górska, M.\*, Kopatch, Y.\*, Lane, G.J., Mandal, S.\*, Milechina, L.\*, Molnár, J.\*, O'Leary, C.\*, Plociennik, W.\*, Pucknell, V.\*, Raddon, P.\*, Redon, N.\*, Ruchowska, E.\*, Stanoiu, M.\*, Tengblad, O.\*, Wheldon, C.\* and Wood, R.\*  
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*Direct Decays from Superdeformed States in 192Pb Observed Using Time-correlated  $\geq$ -ray Spectroscopy*  
 Physical Review Letters 90 (2003) 142501-1-4
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*Breakup and Transfer Processes in the 9Be + 208Pb Reaction*  
 Physical Review C: Nuclear Physics 68 (2003) 014611-1-4
- Refereed Conference Proceedings
- Hagino, K.\*, Dasgupta, M., Gontchar, I.I., Hinde, D.J., Morton, C.R. and Newton, J.O.  
*Surface Diffuseness Anomaly in Heavy-ion Fusion Potential*  
 4th Italy-Japan Symposium on Heavy Ion Physics, RIKEN, Japan (2003) 87-98
- Hinde, D.J., Dasgupta, M. and Mukherjee, A.  
*Inhibition of Fusion by Quasi-fission in Heavy Element Formation*  
 Third International Conference on Fission and Properties of Neutron-Rich Nuclei, Florida, USA (2003) 712-719



Professor Jeffrey Harris

# Plasma Research Laboratory

*Plasmas – ionised gases – comprise most of the visible universe and are also at the core of development of energy, space, materials, and optical and wireless communications technologies for the future. The Plasma Research Laboratory (PRL) conducts research in all these areas, in close collaboration with other laboratory and industry groups around the world.*

The Laboratory's research attracts over \$1M per year in external funding, from the ARC Discovery and Linkage programs, DEST and ACT research grants, Euratom and international industrial contracts. The Laboratory is comprised of six academic and six general staff members, two post-docs, around 12 post graduate students, and 5-10 undergraduate students.

Research in toroidal plasma confinement is carried out by the Toroidal Physics Group, and centers around the H-1 Helic Major National Research Facility. H-1 is a toroidal stellarator magnetic plasma confinement experiment for the study of the plasma physics important in developing fusion energy: that is, to provide renewable electricity generation using light-atom fusion reactions like those that power the Sun and stars.

In 2003, studies of the plasma turbulence in the heliac by Michael Shats and his colleagues demonstrated the role of zonal flows and self-organisation in regulating the outward transport of particles and achieving enhanced confinement regimes.

Heliac experiments carried out by Boyd Blackwell, Jeffrey Harris and their colleagues demonstrated the sensitivity of confinement and fluctuations in the heliac to resonant effects in the magnetic configuration, and a related collaborative experiment on the D3D tokamak in the USA demonstrated the use of spatially-resonant magnetic fields to control the stability of the plasma edge.

John Howard and his colleagues have used heliac experiments to develop a series of novel imaging spectrometers that use electro-optic technology to determine temperatures and flows in radiating media. These techniques are in use on fusion experiments in Europe and the USA, and are being developed for use in defence and steel production.

The Space Physics and Plasma Processing (SP3) Group led by Rod Boswell and Christine Charles have continued to develop the helicon plasma source. The robustness of the concept has led to a large range of applications: basic plasma physics experiments to electronic and optical materials processing and plasma thrusters for space travel. This work is being carried out in collaboration with French and US space scientists.

Other applications of helicon sources include a high brightness ion sources for semiconductor device fabrication (with FEI, Inc, USA) and the fabrication of nano-titre plate technology for drug testing.

Our interest in rf technology has led to the development of the Bush Local Area Network (BushLAN) project, headed by Gerard Borg, which is developing digital VHF (Very High Frequency) wireless technology for use in a novel scheme to provide long-distance (~50 km) Internet connections to regional Australia.

## Department Staff

### Professor and Head of Department

Jeffrey Harris, MS MIT, PhD Wisc, FAPS, FAIP

### Professor

Roderick Boswell, BSc Adel, PhD Flin, FAPS, FTSE, FATS

### Senior Fellows

Boyd Blackwell, BSc PhD Syd

John Howard, BSc PhD Syd

Michael Shats, MSc Kiev Poly Inst, PhD Gen Phys Inst Mosc

### Fellows

Gerard Borg, BSc PhD Syd

Christine Charles, Ingénieur INSA Rennes, PhD Orléans (Australian Photonics CRC)

### Post-doctoral Fellows

Douglas Bulla, PhD Sao Paulo (Australian Photonics CRC))

Wei Tang Li, MSc China, PhD Syd (Australian Photonics CRC)

### Adjunct Fellows

Mr Scott Collis, BSc Syd

Mr Fenton Glass, BSc Qld

Mr Clive Michael, BSc

Mr Horst Punzmann, BSc Polytech Regensburg

**Visiting Fellows**

Joe Baker, MSc PhD Qld, OBE, FTSE  
 Lise Caillault, DEA Orsay, PhD ONERA  
 Andrew Cheetham, BSc PhD Flinders (until February)  
 Braulio de la Fuente (from August)  
 Roger Gammon, Btech PhD Brunel, FinstP, Cphys, MIE Aust, CP  
 Eng, FAIE, FAIM  
 Sydney Hamberger, PhD DSc Lond, FAIP (Emeritus Professor)  
 John Keller, PhD Rensselaer Polytechnic  
 Mike Lieberman, PhD Elect Eng, Berkeley  
 Dennis Mather, BSc PhD UNSW, Dip Ed STC  
 Kazunobo Nagasaki, MSc PhD Kyoto  
 John O'Connor, BSc PhD DSc ANU  
 Alexander Samarin, BSc Moscow, PhD Protvino (jointly with TP)  
 (February to March)  
 Anthony Sproule, ME UT Syd, GradDipOR NSW IT  
 Chang-Fei Wang (from August)  
 Wei-Rong Wu (from August)

**Head Technical Officer**

Clinton Davies

**Senior Technical Officers**

Peter Alexander  
 Robert Davies, AssocDipMechEng, BT Deakin (until May)  
 Ray Kimlin  
 John Wach, BAppSci CAE Ball, GradDipEI CCAE

**Technical Officer**

Costanzo Costa

**Departmental Administrator**

Helen Hawes, BA

**Department Publications**

Legend: \* *External to the University*, # *Member of another area of this University other than this School*, † *Author having a joint appointment across departments within the School*

**Publications in Refereed Journals**

Aanesland, A.\*, Charles, C., Boswell, R.W. and Frederickson, A.\*  
*Sputtering Effects in a Helicon Plasma with an Additional Immersed Antenna*  
*Plasma Sources Science and Technology* 12 (2003) 85-88

Boswell, R.W.  
*Cosmic Waves in the Lab*  
*Nature* 425 (2003) 352-353

Charles, C. and Boswell, R.W.  
*Current-free Double-layer Formation in a High-density Helicon Discharge*  
*Applied Physics Letters* 82 (2003) 1356-1358

Charles, C., Boswell, R.W. and Lieberman, M.  
*Energy Balance in a Low Pressure Capacitive Discharge Driven by a Double-saddle Antenna*  
*Physics of Plasmas* 10 (2003) 891-899

Charles, C.  
*Wall Effects on the Chemistry in a Pulsed Oxygen/Silane Radiofrequency Helicon Plasma*  
*Journal of Physics D: Applied Physics* 36 (2003) 2076-2082

Collis, S.M., Howard, J., Warr, G.B., Michael, C.A., Harris, J.H., Blackwell, B.D. and Pretty, D.G.  
*Studies of Resonantly Produced Plasmas in the H-1NF Heliac Using a Far-infrared Scanning Interferometer*  
*Review of Scientific Instruments* 74 (2003) 1629-1632

Dubost, L.\*, Bellinger, A.\*, Perrin, J.\* and Boswell, R.W.  
*Low Temperature Pulsed Etching of Large Glass Substrates*  
*Journal of Vacuum Science and Technology A* 21 (2003) 892-894

Herrick, A., Perry, A.J. and Boswell, R.W.  
*Etching Silicon by SF<sub>6</sub> in a Continuous and Pulsed Power Helicon Reactor*  
*Journal of Vacuum Science and Technology A* 21 (2003) 955-966

Howard, J., Michael, C.A., Glass, F. and Danielsson, A.\*  
*Time-resolved Two-dimensional Plasma Spectroscopy Using Coherence-imaging Techniques*  
*Plasma Physics and Controlled Fusion* 45 (2003) 1143-1166

Li, W.T.†, Bulla, D.A.P.†, Love, J.D., Luther-Davies, B., Charles, C. and Boswell, R.W.  
*Hydrogen Contamination in Ge-doped SiO<sub>2</sub> Thin Films Prepared by Helicon Activated Reactive Evaporation*  
*Journal of Vacuum Science and Technology A* 21 (2003) 792-796

Punzmann, H., Shats, M.G., Solomon, W.M. and Xia, H.  
*Multichannel Visible Spectroscopy Diagnostic for Particle Transport Studies in the H-1 Heliac*  
*Review of Scientific Instruments* 74 (2003) 2048-2051

Shats, M.G., Punzmann, H., Xia, H. and Solomon, W.M.  
*Measurements of Poloidal Rotation Velocity Using Cross-correlation Spectroscopy in the H-1 Heliac*  
*Review of Scientific Instruments* 74 (2003) 2044-2047

Shats, M.G., Solomon, W.M. and Xia, H.  
*Turbulent Transport Reduction and Randomization of Coherent Fluctuations by Zonal Flows in Toroidal Plasma*  
*Physical Review Letters* 90 (2003) 125002-1-4

Smith, H.B., Charles, C. and Boswell, R.W.  
*Breakdown Behavior in Radio-frequency Argon Discharges*  
*Physics of Plasmas* 10 (2003) 875-881

Squire, J.P.\*, Chang Diaz, F.R.\*, Glover, T.W.\*, Jacobson, V.T.\*, Chavers, D.G.\*, Bengtson, R.D.\*, Bering, E.A.\*, Boswell, R.W., Goulding, R.H.\* and Light, M.\*  
*Progress in Experimental Research of the Vasimr Engine*  
*Fusion Engineering and Design* 43 (2003) 111-117

Xia, H. and Shats, M.G.  
*Inverse Energy Cascade Correlated with Turbulent-structure Generation in Toroidal Plasma*  
*Physical Review Letters* 91 (2003) 155001-1-4

**Refereed Conference Proceedings**

Bulla, D.A.P.†, Li, W.T.†, Charles, C., Boswell, R.W. and Love, J.D.  
*Geometry Effects upon the Transmission Loss in Optical Rib Waveguides Fabricated Using Chemical Etching*  
 COIN/ACOFT 2003, Melbourne (2003) 748-751

Jarvis, R. and Boswell, R.W.  
*Expansion of Germanium Doped Silica Films under UV Irradiation*  
 COIN/ACOFT 2003, Melbourne (2003) 457-460





Professor Vladimir Bazhanov

# Department of Theoretical Physics

*Research within the Department covers fundamental aspects of atomic and molecular physics, biophysics, condensed matter physics, nuclear physics, plasma physics, statistical mechanics and quantum field theory.*

Research highlights for 2003 include the detailed examination of cylindrical plasmas and their connection to quantum chaos theory; the creation of a model describing the observed properties of key ion channels; a quantum kinetic derivation of the Landauer formula in electron transport; clarification of the interplay between localised moments and conduction electrons in strongly correlated electron systems; new analytical results for the thermodynamics of the Coqblin-Schrieffer model for magnetic impurities and the application of exactly solved models to the physics of strongly coupled ladder compounds.

In 2003 the Department continued its strong success in competitive funding. In addition to the \$675K in ARC Discovery grants held for 2003, major new Discovery grants awarded from 2004 totalled \$650K. The new projects were for research on toroidal plasmas (Dewar), ion channels (Kuyucak) and protein interactions (Kuyucak, Bastug). Professor Dewar was Coordinator of a successful bid for an ARC Special Research Initiatives Seed Funding Grant on Energetically Open Systems. Success was also obtained in Linkage International with a Fellowship awarded to Dr Benedicte Ponsot from France (Bazhanov). Professor Batchelor took up his Australian Professorial Fellowship from 1 January. New members of staff, also supported by the ARC, were Dr Sergeev, Dr Guan and Dr. Mangazeav.

During the year Professors Bazhanov and Dewar made extended visits to Japan under the Outside Studies and Professional Development Program. Dr Das was elected as a Fellow of the American Physical Society. Other highlights included the selection of Ben Corry's PhD thesis on ion channels as the best thesis from the ACT region for entry in the 2002 Bragg Medal for Excellence in Physics.

The Department is host to the Centre for Complex Systems (CCS). The Centre's activities are highlighted elsewhere.

## Department Staff

**Professor and Head of Department**  
Vladimir Bazhanov, PhD Serpukhov

### Professors

Nail Akhmediev, DSc USSR Acad Sci

Murray Batchelor, BSc UNSW, PhD ANU, FAIP, FaustMS (ARC Fellowship) (jointly with Mathematical Sciences Institute)  
Robert Dewar, MSc Melb, PhD Princ, FAIP, FAPS, FAA

### Senior Fellows

Shin-Ho Chung, PhD Harv (NHMRC Professorial Fellow)  
Mukunda Das, MSc Utkal, PhD Roorkee, FAPS, FAIP, CPhys.FInstP  
Miklos Gulacsi, BSc MSc Cluj, PhM PhD Trieste  
Anatoli Kheifets, Msc PhD St Petersburg (jointly with Atomic and Molecular Physics Laboratories)  
Serdar Kuyucak, BSc Ankara, PhD Yale

### Fellows

Miklos Gulacsi, BSc MSc Cluj, PhM PhD Trieste  
Wen Xu, BSc, MSc, PhD Antwerp

### Research Fellows

Rowena Ball, BSc, PhD Macquarie (ARC Fellowship)  
Xi-Wen Guan, BSc Qufu, MSc Sichuan, PhD Jilin (jointly with Igor Ivahov, MSc MPTI, PhD Isan (jointly with AMPL) Mathematical Sciences Institute) (from February)  
Sudip Sen, MSc, PhD UMIST (until December)  
Sergei Sergeev, MSc Moscow, PhD Serpukhov, 2nd PhD St Petersburg (from June)

### Post-doctoral Fellow

Turgut Bastug, BSc Ankara, PhD Kassel (until December)  
Matthew Hoyles, BSc ANU

### Visiting Fellows

Fred Barker, MSc Melb, PhD Birm (Emeritus Professor)  
Conrad Burden, BSc Qld, PhD ANU  
Fricke Burkhard, DiplPhys Darmstadt, PhD Frankfurt (from December)  
Jorgen Frederiksen, BSc Adelaide, PhD ANU, DSc Adelaide (from October)  
Harald Friedrich, DipPhys Freib, Dr rer nat Munst (jointly with Atomic and Molecular Physics Laboratories) (until March)  
Michael Hall, MSc PhD ANU  
Graeme Honner, BSc LaTrobe  
Kailash Kumar, BSc Agra, MSc AILD, PhD McM, FAIP  
Sergei Kun, MS PhD Kiev

Mihajlo Mudrinic, BSc MSc PhD Belgrade  
 Jinlan Nie, BSc Sichuan China  
 Benedicte Ponsot, BSc Paris VI, PhD Montpellier II (March)  
 Brian Robson, MSc PhD DSc Melb, FAIP  
 Robert Robson, BSc Qld, DipMet, PhD, FRMS, FAPS, FAIP (until October)  
 (jointly with Atomic and Molecular Physics Laboratories)  
 Alexander Samarin, BSc Moscow, PhD Protvino (jointly with PRL) (February to March)  
 Harold Schranz, BSc PhD USyd (until August)  
 Susan Scott, BSc Monash, PhD Adel  
 Michael Simpson, BSc Adel, PhD Newcastle  
 Irina Talanina, MSc PhD GPI Moscow  
 Lindsay Tassie, MSc PhD Melb, FAIP  
 Guy White, BScSyd, PhD Oxford, DSc Woolongong  
 William Woolcock, BSc Qld, PhD Camb, FAIP

### Departmental Administrators

Mrs Sharon Lopez  
 (part time, until March)  
 Mrs Trina Merrell (part time, from April)

## Department Publications

Legend: \* External to the University, # Member of another area of this University other than this School, † Author having a joint appointment across departments within the School

### Books and Book Chapters

Akhmediev, N.N. and Ankiewicz, A.  
*Solitons Around Us: Integrable, Hamiltonian and Dissipative Systems*  
 in *Optical Solitons: Theoretical and Experimental Challenges*, Springer-Verlag, Germany (2003) 105-126

Ball, R. (Editor), *Nonlinear Dynamics: From Lasers to Butterflies*, World Scientific, Singapore, 2003

Ball, R., Dewar, R.L. and Sugama, H.\*  
*Bifurcation and Metamorphosis of Plasma Turbulence-shear Flow Dynamics: The Path to the Top of the Hill*  
 in *Plasma Physics: ICPP2002*, American Institute of Physics, USA (2003) 711-714

Das, M.P. and Green, F.  
*The Landauer Formula: A Magic Mantra Revisited*  
 in *Condensed Matter Theories Vol 18*, Nova Science Publishers, New York (2003) 441-453

Green, F. and Das, M.P.  
*Mesoscopic Transport as Many-body Physics*  
 in *Condensed Matter Theories Vol 17*, Nova Science Publishers, New York (2003) 83-102

McMillan, B.F., Dewar, R.L. and Storer, R.G.\*  
*A Broken Degeneracy in the Resistive MHD Spectrum*  
 in *Plasma Physics: ICPP2002*, American Institute of Physics, USA (2003) 577-580

Town, G.E.\*, Akhmediev, N.N. and Soto-Crespo, J.M.\*  
*Optical Fiber Soliton Lasers*  
 in *Optical Solitons: Theoretical and Experimental Challenges*, Springer-Verlag, Germany (2003) 265-297

Xu, W., Lewis, R.A.\*, Koenraad, P.M.\*, Waumans, L.R.\* and Langerak, C.J.\*  
*Magnetophoton-phonon Scattering in Two-dimensional Electron Gases*  
 in *Condensed Matter Theories Vol 17*, Nova Science Publishers, New York (2003) 373-382

### Publications in Refereed Journals

Akhmediev, N.N. and Soto-Crespo, J.M.\*  
*Exploding Solitons and Shil'nikov's Theorem*  
*Physics Letters A* 317 (2003) 287-292

Allen, T.W.#, Bastug, T., Kuyucak, S. and Chung, S.-H.\*  
*Gramicidin a Channel as a Test Ground for Molecular Dynamics Force Fields*  
*Biophysical Journal* 84 (2003) 2159-2168

Ankiewicz, A., Maruno, K.-I. and Akhmediev, N.N.  
*Periodic and Optical Soliton Solutions of the Quintic Complex Swift-Hohenberg Equation*  
*Physics Letters A* 308 (2003) 397-404

Ankiewicz, A. and Akhmediev, N.N.  
*Stability Analysis for Solitons in Planar Waveguides, Fibers and Couplers Using Hamiltonian Concepts*  
*IEE Proceedings Optoelectronics* 150 (2003) 519-526

Barker, F.C.  
*Erratum: 6Be and 8C Level Widths*  
*Physical Review C: Nuclear Physics* 67 (2003) 049902-1

Barker, F.C.  
*R-matrix Formulas for Three-body Decay Widths*  
*Physical Review C: Nuclear Physics* 68 (2003) 054602-1-5

Bastug, T. and Kuyucak, S.  
*Role of the Dielectric Constants of Membrane Proteins and Channel Water in Ion Permeation*  
*Biophysical Journal* 84 (2003) 2871-2882

Batchelor, M.T., Guan, X.-W., Oelkers, N., Sakai, K.\*, Tsuboi, Z.\* and Foerster, A.\*  
*Exact Results for the Thermal and Magnetic Properties of Strong Coupling Ladder Compounds*  
*Physical Review Letters* 91 (2003) 217202-1-4

Batchelor, M.T., Burne, R.V.#, Henry, B.I.\* and Watt, S.D.\*  
*Mathematical and Image Analysis of Stromatolite Morphogenesis*  
*Mathematical Geology* 35 (2003) 789-803

Batchelor, M.T., Guan, X.-W., Foerster, A.\* and Zhou, H.-Q.\*  
*Note on the Thermodynamic Bethe Ansatz Approach to the Quantum Phase Diagram of the Strong Coupling Ladder Compounds*  
*New Journal of Physics* 5 (2003) 107.1-107.9

Batchelor, M.T., Guan, X.-W., Foerster, A.\*, Tonel, A.\* and Zhou, H.-Q.\*  
*Thermodynamic Properties of an Integrable Quantum Spin Ladder with Boundary Impurities*  
*Nuclear Physics B* 669 (2003) 385-416

Bazhanov, V.V., Lukyanov, S.L.\* and Tselvik, A.M.\*  
*Analytical Results for the Coqblin-Schrieffer Model with Generalized Magnetic Fields*  
*Physical Review B* 68 (2003) 094427-1-5

Bazhanov, V.V., Lukyanov, S.L.\* and Zamolodchikov, A.B.\*  
*Higher-level Eigenvalues of Q-operators and Schrödinger Equation Advances in Theoretical and Mathematical Physics* 7 (2003) 711-725

Brosche, P.\*, Lenters, F.\* and Tassie, L.J.  
*A Mass Ratio Limit for Primordial Black Holes*  
*Astronomische Nachrichten* 324 (2003) 556-559

Brown, B.A.\* and Barker, F.C.  
*Di-Proton Decay of 45Fe*  
*Physical Review C: Nuclear Physics* 67 (2003) 041304-1-3

Corry, B., Kuyucak, S. and Chung, S.-H.#  
*Dielectric Self-energy in Poisson-Boltzmann and Poisson-Nernst-Planck Models of Ion Channels*  
*Biophysical Journal* 84 (2003) 3594-3606

Das, M.P. and Green, F.  
*Landauer Formula without Landauer's Assumptions*  
*Journal of Physics: Condensed Matter* 15 (2003) L687-L693

Dewar, R.L.†  
*Spectrum of Global Ideal-magnetohydrodynamic Three-dimensional Ballooning Modes*  
*Space Science Reviews* 107 (2003) 349-352 (also listed under Plasma Research Laboratory)

Guimaraes, V.\*, Kubono, S.\*, Barker, F.C., Hosaka, M.\*, Jeong, S.C.\*, Katayama, I.\*, Miyachi, T.\*, Nomura, T.\*, Tanaka, M.H.\*, Fuchi, Y.\*, Kawashima, H.\*, Kato, S.\*, Yun, C.C.\*, Ito, K.\*, Orihara, H.\*, Terakawa, T.\*, Kishida, T.\*, Pu, Y.\*, Hamada, S.\*, Hirai, M.\* and Miyatake, H.\*  
*Structure of the Unbound 11N Nucleus by the (3He, 6He) Reaction*  
*Physical Review C: Nuclear Physics* 67 (2003) 064601-1-8

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Professor John Love

# Applied Photonics Group

The Applied Photonics Group specialises in the design of novel planar and fibre light processing devices. The Group is strongly linked to experimental photonics groups within the School, across campus and within the Australian Photonics CRC; it provides a wealth of experience and insight into the research, modelling and design of photonic devices and photonic integrated circuits.

The Group continues to be innovative through the design and analysis of novel light-processing devices based on optical fibre and planar waveguides for optical telecommunications networks and systems in particular and for other practical applications. It also provides analytical and modelling support to several other research groups and research students within the School, including the Space Plasma and Plasma Processing Group and the Optical Sciences Centre, as well as to groups within the Australian Photonics CRC. Industrial research work has been undertaken for DSTO and Australian photonics companies, including Redfern Polymer Optics Pty Ltd on campus. In other areas, there is a major contribution to a wide range of outreach activities in the School, as well as to photonics schools and workshops in southeast Asia organised in collaboration with the Photonics Institute Pty Ltd at Bruce.

Another key focus by the Group is on photonics undergraduate teaching in the Department of Physics through convening, presenting and demonstrating six bachelor and masters courses, together with two distance learning courses.

## Group Staff

### Professor and Head of Group

John Love, MA Camb, MA DPhil DSc Ox

### Fellow

Adrian Ankiewicz, BSc BE UNSW, PhD ANU (Australian Photonics CRC)

### Postdoctoral Fellows

Douglas Bulla, PhD Sao Paulo (jointly with Plasma Research Laboratory)

### Visiting Fellows

Satis Arnold, BSc MSc NSW, Murdoch Uni  
Martin Elias, ADC Australia Pty Ltd  
Andrew Stevenson, Photonics Institute,

BSc PhD ANU

Snjezana Tomljenovic-Hanic, PhD ANU (from June)

François Ladouceur, UNSW

Stephen Scheeler, Sydney

### Departmental Administrator

Wendy Quinn, BA

## Group Publications

Legend: \* External to the University, # Member of another area of this University other than this School, † Author having a joint appointment across departments within the School

### Publications in Refereed Journals

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