



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 Juodkakis 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 St'ou, 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 Jingdezhen, 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.* , 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

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

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

Feliz, M.* , Llusar, R.* , Uriel, S.* , Vicent, C.* , 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)
Inorganica Chimica Acta 349 (2003) 69-77

Garriga, J.M.* , Llusar, R.* , Uriel, S.* , Vicent, C.* , Usher, A.J.# , Lucas, N.T.# , Humphrey, M.G.# and Samoc, M.
Synthesis and Third-order Nonlinear Optical Properties of [Mo3(3-S)2(2-S)2]4+ Clusters with Maleonitriledithiolate, Oxalate and Thiocyanate Ligands
Dalton Transactions 23 (2003) 4546-4551

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

Halliwell, X.W., Friedrich, H., Gibson, S.T. and Baldwin, K.G.H.†
Quantum Reflection of Metastable Helium 23S Atoms in Hollow Optical Fibres
Optics Communications 224 (2003) 89-95

Hurst, S.K.# , Lucas, N.T.# , Humphrey, M.G.# , Isoshima, T.* , Wostyn, K.* , Asselberghs, I.* , Clays, K.* , Persoons, A.* , Samoc, M. and Luther-Davies, B.
Organometallic Complexes for Nonlinear Optics. Part 29. Quadratic and Cubic Hyperpolarizabilities of Stilbenylethynyl-gold and -ruthenium Complexes
Inorganica Chimica Acta 350 (2003) 62-76

Hurst, S.K.# , Humphrey, M.G.# , Morrall, J.P.# , Cifuentes, M.P.# , Samoc, M., Luther-Davies, B., Heath, G.W.# and Willis, A.C.#
Organometallic Complexes for Nonlinear Optics. Part 31. Cubic Hyperpolarizabilities of Ferrocenyl-linked Gold and Ruthenium Complexes
Journal of Organometallic Chemistry 670 (2003) 56-65

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

Kolev, V.Z., Lederer, M.J., Luther-Davies, B. and Rode, A.V.
Passive Mode Locking of a Nd:YVO4 Laser with an Extra-long Optical Resonator
Optics Letters 28 (2003) 1275-1277

Kono, M., Lewis, B.R., Baldwin, K.G.H.† and Gibson, S.T.
Experimental Verification of Line- and Band-shape Asymmetry in the Schumann-Runge System of O2
Journal of Chemical Physics 118 (2003) 10924-10928 (also listed under Atomic & Molecular Physics Laboratories)

Krolkowski, W., Bang, O.* , Wyller, J.* and Rasmussen, J.J.*
Optical Beams in Nonlocal Nonlinear Media
Acta Physica Polonica Series A 103 (2003) 133-147

Krolkowski, W., Luther-Davies, B. and Denz, C.*
Photorefractive Solitons
IEEE Journal of Quantum Electronics 39 (2003) 3-12

- Krolikowski, W., McCarthy, G., Kivshar, Yu.S., Weilnau, 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
- Li, W.T.[†], Bulla, D.A.P.[†], Love, J.D., Luther-Davies, B., Charles, C. and Boswell, R.W.
Hydrogen Contamination in Ge-doped SiO₂ Thin Films Prepared by Helicon Activated Reactive Evaporation
Journal of Vacuum Science and Technology A 21 (2003) 792-796
- 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
- Powell, C.E.[#], Cifuentes, M.P.[#], Morrall, J.P.[#], Stranger, R.[#], Humphrey, M.G.[#], Samoc, M., Luther-Davies, B. and Heath, G.A.
Organometallic Complexes for Nonlinear Optics. 30. Electrochromic Linear and Nonlinear Optical Properties of Alkynylbis(diphosphine)ruthenium Complexes
Journal of the American Chemical Society 125 (2003) 602-610
- Powell, C.E.[#], Humphrey, M.G.[#], Cifuentes, M.P.[#], Morrall, J.P.[#], Samoc, M. and Luther-Davies, B.
Organometallic Complexes for Nonlinear Optics. 33. Electrochemical Switching of the Third-order Nonlinearity Observed by Simultaneous Femtosecond Degenerate Four-wave Mixing and Pump-probe Measurements
Physical Chemistry Chemical Physics 107 (2003) 11264-11266
- 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
- Samoc, A.
Dispersion of Refractive Properties of Solvents: Chloroform, Toluene, Benzene and Carbon Disulfide in Ultraviolet, Visible and Near-infrared
Journal of Applied Physics 94 (2003) 6167-6174
- Samoc, A., Samoc, M., Luther-Davies, B., Freydank, A.C. and Lucas, N.T.[#]
Investigations into Nonlinear Optical Chromophores with Femtosecond Degenerate Four-wave Mixing in Solutions
Journal of Nonlinear Optical Physics and Materials 12 (2003) 235-246
- Samoc, M., Samoc, A. and Luther-Davies, B.
Third Harmonic Autocorrelation and Wave Mixing in a Thin Film of Poly(p-phenylenevinylene)
Optics Express 11 (2003) 1787-1792
- Samoc, M., Samoc, A., Luther-Davies, B., Humphrey, M.G.[#] and Wong, M.-S.*
Third-order Optical Nonlinearities of Oligomers, Dendrimers and Polymers Derived from Solution Z-scan Studies
Optical Materials 21 (2003) 485-488
- Sprengers, J.P.*^{*}, Ubachs, W.*^{*}, Baldwin, K.G.H.[†], Lewis, B.R. and Tchang-Brillet, W.L.*
Extreme Ultraviolet Laser Excitation of Isotopic Molecular Nitrogen: The Dipole-allowed Spectrum of ¹⁵N₂ and ¹⁴N₂
Journal of Chemical Physics 119 (2003) 3160-3173
- Taunamang, H.*^{*}, Herman, H.*^{*}, Tjia, M.O.*^{*} and Samoc, M.
Electric Field Induced Second Harmonic Generation in Vacuum Evaporated Disperse Red 1 Films
Optical Materials 22 (2003) 289-294
- Tomljenovic-Hanic, S. and Krolikowski, W.
New Design for a Variable Optical Attenuator Based on a Bent Channel Waveguide
Applied Physics B Lasers and Optics 77 (2003) 19-23
- White, R.T.*^{*}, He, Y.*^{*}, Orr, B.J.*^{*}, Kono, M. and Baldwin, K.G.H.[†]
Pulsed Injection-seeded Optical Parametric Oscillator with Low Frequency Chirp for High-resolution Spectroscopy
Optics Letters 28 (2003) 1248-1250
- Wilson, E., Manson, N. and Wei, C.
Perturbing an Electromagnetic Induced Transparency within an Inhomogeneously Broadened Transition
Physical Review A 67 (2003) 023812-1-10
- Zakery, A.*^{*}, Ruan, Y., Rode, A.V., Samoc, M. and Luther-Davies, B.
Low-loss Waveguides in Ultrafast Laser-deposited As₂S₃ Chalcogenide Films
Journal of the Optical Society of America B 20 (2003) 1844-1852
- 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
- 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
- Lucas, N.T.[#], Notaras, E.G., Humphrey, M.G.[#], Samoc, M. and Luther-Davies, B.
Syntheses, Characterization and Optical Limiting Properties of Heterometallic Cluster-containing Polymers
Linear and Nonlinear Optics of Organic Materials 111, San Diego, USA (2003) 318-325
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Synthesis of Low-OH Photosensitive Ormosil Polymers Via Anhydrous Sol-gel Process for Integrated Optics
COIN/ACOFT 2003, Melbourne (2003) 353-356
- Luo, X., Zha, C. and Luther-Davies, B.
Synthesis of Photosensitive Organic-inorganic Hybrid Polymers Via Anhydrous Sol-gel Process for Integrated Optics
Advanced Optical Processing of Materials Symposium, San Francisco, USA (2003) 169-174
- Luther-Davies, B., Kolev, V.Z., Lederer, M.J., Yinlan, R., Samoc, M., Jarvis, R., Rode, A.V., Gieseckus, J.*^{*}, Du, K.-M.*^{*}, Duering, M.*^{*} and Zakery, N.*^{*}
Low Loss Chalcogenide Glass Waveguides Produced by Pulsed Laser Deposition
COIN/ACOFT 2003, Melbourne (2003) 733-635
- Luther-Davies, B., Kolev, V.Z., Lederer, M.J., Ruan, Y., Samoc, M., Jarvis, R., Rode, A.V., Gieseckus, J.*^{*}, Du, K.-M.*^{*} and Duering, M.*^{*}
Ultrafast Pulsed Laser Deposition of Chalcogenide Glass Films for Low-loss Optical Waveguides
Advanced Optical Processing of Materials Symposium, San Francisco, USA (2003) 131-142
- 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.[†] 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.*^{*}, 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)