

Curriculum Vitae

Matthew R. Arnison

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Current position and address

Postgraduate Research Student
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Personal details

Born 22nd November, 1971, in Sydney, Australia. Australian citizen.

Education

1993 B. Sc. (Hons II.1, Physics) University of Sydney.
1989 Higher School Certificate (placed in top 1% of NSW state).

Summary of professional experience

1999– Research Student (Ph.D.), Physical Optics Laboratory, School of Physics, University of Sydney. Supervisors: C. J. R. Sheppard, C. J. Cogswell, M. Sharma.
1999– Tutor and Demonstrator, Undergraduate Physics. School of Physics, University of Sydney.
1996 Online Co-ordinator (part time), Community Broadcasting Association of Australia, Sydney, Australia.
1994–1996 Computational Scientist (part time), Sydney Regional Scientific Visualisation Laboratory, University of Sydney.
1994–1999 Research Scientist (part time), Physical Optics Department, School of Physics, University of Sydney.
1992 Laboratory Demonstrator, First Year Physics, School of Physics, University of Sydney.
1991 Vacation Scholarship, Physical Optics Department, School of Physics, University of Sydney.
1987–1994 Computer Programmer (part time), Spectrum Group (market research), Sydney, Australia.

Research experience

International experience

- 2001 Delft University of Technology, Netherlands, as a guest of J. Braat (1 week).
- 2000–2001 Oxford University, UK, collaboration with P. Török (6 weeks total).
- 2000 Osaka University, Japan, collaboration with S. Kawata group (1 month).
- 1999–2001 Colorado University, USA, collaboration with W. T. Cathey group (3 months total).

Theoretical optics

- Extension of vectorial optical transfer function theory to model pupil functions without radial symmetry.
- Application of vectorial diffraction theory to model a strong cubic phase aberration for modeling wavefront coding in high aperture microscopy. In collaboration with P. Török, Imperial College, UK.

Instrumentation

- Application of wavefront coding to high aperture high resolution fluorescence microscopy. Development of point spread function measurement techniques. Observation of biological specimens using wavefront coding to give extended depth of field. This pioneer method has since been licensed by Zeiss and Olympus. In collaboration with W. T. Cathey group, Colorado University, USA.
- Design and construction of an experimental confocal laser scanning microscope capable of producing three-dimensional images in both reflection and transmission modes. Development of software for interactive control of the microscope, including its scanning stage, data acquisition, and image display systems.
- Development of a high-speed aberration detection and correction system for confocal transmission modes using tip/tilt mirrors, and adaptive optics. Phase retrieval experiments for detection of higher order aberrations.

Biological applications

- Biological imaging utilising confocal and conventional microscopes, focusing on development of new high-resolution imaging techniques. Imaging modes explored include brightfield, Nomarski differential interference contrast (DIC), fluorescence, and full-colour imaging with red, green, and blue lasers.

Digital image processing and visualisation

- Development of computer algorithms for improving visualisation of 3D datasets. Techniques include Fourier based precision alignment of successive 2D serial sections from 3D datasets (in our case from confocal microscopes); reconstruction of phase from DIC mode using the Hilbert transform.
- Development of computer algorithms for feature extraction from microscope images. Special areas of interest include using Fourier transform, local energy, and neural net techniques for extracting object features from the background (such as chromosomes from surrounding cytoplasm in Nomarski DIC datasets) and investigating stereoscopic display. Selected work in collaboration with Dr. L. Guan, Department of Electrical Engineering, University of Sydney.

Teaching experience

School of Physics, University of Sydney

- Experiment design and development for teaching laboratories.
- Laboratory demonstrator for undergraduate experimental physics.
- Tutor in undergraduate computational physics and computational science.
- *Signal and Image Processing*. Fourth year / graduate level course with lectures, digital programming laboratory and research projects. Assisted course development and supervised research projects.

Physical Optics Laboratory, University of Sydney

- Assisted supervision of several honours and graduate students researching confocal microscopy and digital image processing.
- Informal training of fellow group members in research computing.

Sydney Regional Scientific Visualisation Laboratory, University of Sydney

- *VoxelView*. Developed and gave workshop on scientific volume rendering of 3D datasets.
- *Using the Web* and *Web Writing*. Developed and gave workshops on accessing the web and writing web pages (with N. Bordes and G. Horne).
- Informal training of scientific and general users on scientific visualisation techniques.

Community Broadcasting Association of Australia

- Training community radio station staff in use of internet facilities, on location and remotely for 11 stations across Australia.

Administrative experience

Physical Optics Laboratory, University of Sydney

- 2000 Member, Local Organising Committee, Sixth International Conference on Optics Within Life Sciences (Sydney, Australia, 2000).
- 1998–1999 Grant applications: co-authored Australian Research Council (ARC) Small Grants (Chief Investigators: C. J. Cogswell and C. J. R. Sheppard) and assisted with USA National Institute for Health grant applications.
- 1997 Authored grant applications: University of Sydney High Performance Computing and Visualisation Internal Grant (with C. J. Cogswell) and University of Sydney Major Equipment Grant.
- 1996 Held position on the School of Physics Computer Committee.
- 1995 Assisted in development and subsequent management of successful ARC Large Grant 1996–1998 (C. J. Cogswell, J. W. O’Byrne, C. J. Sheppard).
- 1994–1999 Responsible for research computing in the laboratory, including computer purchasing and management.

Community Broadcasting Association of Australia

- Managed Federal Department of Social Security grant including full budget management, and regular and concluding reporting.
- Co-ordinated live website from national conference with a staff of 7 publishing hourly updates (text, pictures and sound) on session proceedings.

Personal scholarships and grants awarded

- 2001 New Focus Student Travel Grant, Optical Society of America.
- 1999, 2001 James Kently Memorial Scholarship, Grants-In-Aid, University of Sydney.
- 1999–2003 Sydney University Physics Scholarship.

Publications

- M. R. Arnison, C. J. Cogswell, C. J. R. Sheppard, and P. Török, “Wavefront coding fluorescence microscopy using high aperture lenses,” in *Optical imaging and microscopy: techniques and advanced systems*, P. Török and F.-J. Kao, eds., (Springer, 2003), (in press).
- M. R. Arnison and C. J. R. Sheppard, “A 3D vectorial optical transfer function suitable for arbitrary pupil functions,” *Opt. Commun.* **211**, 53–63 (2002).
- M. Kyan, L. Guan, M. Arnison, and C. Cogswell, “Feature extraction of chromosomes from 3D confocal microscope images,” *IEEE Transactions in Biomedical Engineering* **48**, 1306–1318 (2001).
- M. R. Arnison, C. J. Cogswell, N. I. Smith, P. W. Fekete, and K. G. Larkin, “Using the Hilbert transform for 3D visualisation of differential interference contrast microscope images,” *J. Microsc.* **199**, 79–84 (2000).
- P. J. Cronin, P. W. Fekete, M. R. Arnison, and C. J. Cogswell, “Characterisation of an open-loop controlled scanning stage using a knife edge optical technique,” *Review of Scientific Instruments* **71**, 118–123 (2000).
- P. T. A. Nguyen, R. Romagnoli, P. Fekete, M. R. Arnison, L. Guan, and C. J. Cogswell, “A self-organizing map for extracting features of chromosomes in microscopy images,” *Aust. J. Intel. Inform. Proc. Sys.* **5**, 34–38 (1998).

Academic presentations

- M. R. Arnison and C. J. R. Sheppard, “Three dimensional optical transfer functions for high aperture systems with non-symmetric pupils,” *Australian Optical Society Conference*, (Sydney, Australia, 2002).
- M. R. Arnison, C. J. R. Sheppard, and P. Török, “High aperture wavefront coding,” *Focus on Microscopy*, (Kaohsiung, Taiwan, 2002), (invited talk).
- M. R. Arnison, P. Török, C. J. R. Sheppard, W. T. Cathey, E. R. Dowski Jr., and C. J. Cogswell, “A model for wavefront coding in high numerical aperture microscopy,” *Optical Society of America Annual Meeting*, (Long Beach, CA, USA, 2001).
- M. Arnison, P. Török, C. Sheppard, W. Cathey, E. Dowski, Jr., and C. Cogswell, “High resolution extended depth of field microscopy using wavefront coding,” *Students International Symposium on Advanced Engineering*, (Osaka, Japan, 2000), (invited talk).
- M. Arnison, P. Török, C. Sheppard, W. Cathey, E. Dowski Jr., and C. Cogswell, “Wavefront coding in high numerical aperture microscopy,” *Australian Optical Society XIII*, (Adelaide, Australia, 2000).
- C. J. Cogswell, M. R. Arnison, E. R. Dowski, S. C. Tucker, and W. T. Cathey, “Wavefront Coding Gives Rise to a Fast Extended-Depth-of-Focus Fluorescence Microscope,” *Optics Within the Life Sciences VI*, (Sydney, Australia, 2000).
- M. R. Arnison, P. W. Fekete, and C. J. Cogswell, “Phase retrieval techniques for adaptive optics on a confocal microscope,” *Focus on Microscopy*, (Sydney, Australia, 1998).
- M. R. Arnison, P. W. Fekete, M. Serrano, P. T. A. Nguyen, R. Romagnoli, L. Guan, J. W. O’Byrne, and C. J. Cogswell, “Transmission confocal microscopy: making it a reality,” *Three-dimensional and multidimensional microscopy: image acquisition and processing V*, **3261**, 50–59 (International Society for Optical Engineering (SPIE), San Jose, California, USA, 1998).
- M. R. Arnison, P. W. Fekete, P. J. Cronin, J. W. O’Byrne, and C. J. Cogswell, “Detecting aberrations using wavefront curvature sensing on a confocal microscope,” *Australian Optical Society Conference*, (Adelaide, Australia, 1997).
- M. R. Arnison, N. Bordes, G. D. Horne, and B. Pailthorpe, “The World Wide Web for physicists,” *School of Physics colloquium*, (University of Sydney, Australia, 1995).
- C. J. Cogswell, K. G. Larkin, and M. R. Arnison, “2D and 3D Fourier transforms provide powerful tools for confocal microscopy image processing and visualisation,” *Australian Optical Society Conference*, (Brisbane, Australia, 1995).
- M. R. Arnison, C. J. Cogswell, K. G. Larkin, and J. W. O’Byrne, “A multiple optical mode confocal laser scanning microscope: II. Transmission image acquisition, analysis and 3D visualisation,” *Australian Conference on Optics, Lasers and Spectroscopy*, (Melbourne, Australia, 1993).

Honours thesis

Arnison, M. R. (1993). Transmission imaging in confocal microscopy. *Physical Optics Department, School of Physics, University of Sydney*: 36 pages.

Abstract: The difficulty of maintaining optical alignment in transmission confocal scanning laser microscopy has discouraged research in this area. New alignment methods which produce high resolution images of highly transparent biological objects are presented. The imaging properties of confocal transmission brightfield and confocal transmission differential interference contrast were investigated and compared against the conventional case. A technique for quantitative assessment of 3-D frequency response was implemented. 3-D visualisation methods for confocal transmission data sets were explored. Confocal transmission imaging was found to be a high resolution method for investigating weakly transparent objects, and shows promise for further development.

Computational experience

- Programming roles: conception, design, user interface, database design, programming, testing, debugging, user support, user training.
- Projects – from small scripts to large packages: numerical simulation, data acquisition, data analysis, image processing, visualisation, web services.
- Languages: C, MATLAB, LabVIEW, perl, PHP, SQL, Pascal, BASIC and numerous application scripting languages.
- Commonly used applications: Word, Excel, Powerpoint, Adobe Photoshop, Adobe Illustrator, Mathematica, L^AT_EX.
- Operating systems: Windows, Unix, Macintosh.
- Network administration: ethernet TCP/IP network design and deployment; email, database, web and file server setup and maintenance.

Community service

- Community media: internet, video and radio.
 - Scripting, technical production, presentation, training and co-ordinator roles in local and global community media environments.
 - Groups include: Community Activist Technology, Active Sydney, Indymedia.org, Community Access TV, Community Broadcasting Association of Australia Virtual Conference, Sydney Uni TV, Radio 2SER, Hornsby Kuring-gai Radio, Sydney Uni Dramatic Society (film project).
- Free software: contribution to various open source software projects including advocacy, organisation, coding, bug filing, patches, and documentation.
- Bicycle advocacy: Critical Mass rides; bicycle path planning for Wolli Creek Valley in Sydney.