MACQUARIE UNIVERSITY

MQ PHOTONICS RESEARCH CENTRE

ISSUE 1, 2010

Welcome to our newsletter from Macquarie University's *MQ Photonics* Research Centre

The *MQ Photonics* Research Centre in Sydney, Australia, formed in 2007, brings together a team of researchers with long standing expertise in lasers and optical physics. The Centre has approximately 40 active research staff and 30 postgraduate students. Interests and activities within the *MQ Photonics* Research Centre are wide-ranging and provide a rigorous research setting with world class facilities, strong links to industry complemented by a strong cohort of entrepreneurial alumni, and active collaborations with major international research groups in photonics.

What we do

The *MQ Photonics* Research Centre is nationally and internationally recognised for innovation and leadership in lasers and photonics. Our reputation is built on a balance of both fundamental and applied research in the following seven frontiers of optical science:

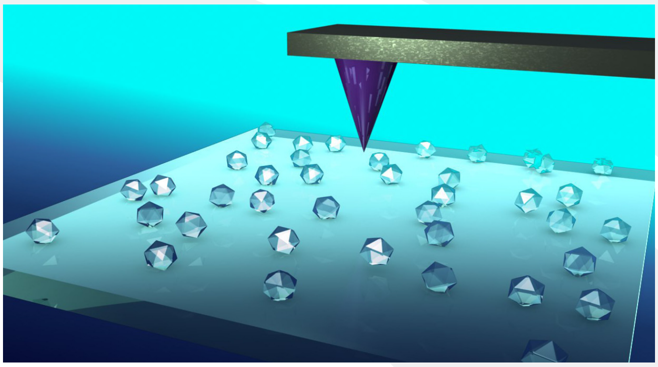
- Astrophotonics
- Biophotonics
- Microphotonic optical systems
- Nano-optics and nanophotonics
- Photonic sources
- Optical sensing and imaging
- Ultrafast laser applications.

Please see overleaf for more information regarding our activities within these research themes.

Higher degree research

Higher degree research (HDR) opportunities are available within the *MQ Photonics* Research Centre. Prospective HDR students are offered a versatile selection of challenging postgraduate research projects for PhD and Masters candidacy, together with scholarships for suitably qualified applicants. Co-tutelle scholarships are also available for suitable students from selected overseas universities. The Centre also has an active program of student exchanges with major international research groups and research student participation at leading international conferences.

RESEARCH FOCUS



A/Profs Jim Rabeau and Andrei Zvyagin have recently undertaken measurements of the smallest diamonds every reported to contain optically active "colour centres". The diamonds were only 5 nm in diameter, and it was also observed that the emitted light blinks on and off. This blinking effect is contrary to the generally accepted view that this is a problem reserved for quantum dots, not nanodiamonds. These results have been published in a *Nature Nanotechnology* paper (Bradac, Gaebel et al. Vol. 5, p. 345-349). This work has triggered several commentaries from other researchers in the field since appearing in press.

News update

- Congratulations to those members of *MQ Photonics* who are investigators on the new ARC Centre of Excellence – Engineered Quantum Systems (EQuS), and renewed ARC Centre of Excellence – Ultrahigh-bandwidth Devices for Optical Systems (CUDOS). This funding, spanning the next seven years, will enable new growth and direction in several *MQ Photonics* research focus areas.
- Similarly, congratulations to Dr Russell Connally for picking up the Judges' and People's Choice awards on the ABC "New Inventors" 30 June program for his Gated Autosynchronous Luminescence Detector (GALD) system.
- Dr Jon Lawrence has taken up a new position as Head of Instrument Science at the AAO. As David Coutts (Head of Department) wrote: "This is a very positive development for the Department. While Jon is moving on to a more senior position, he will retain his strong association with us, and we will have an additional joint position with the AAO thereby boosting our growing Astrophotonics team and strengthening the links between *MQ Photonics*, the Astronomy group and the AAO."

PART OF THE QUEST COMMUNITY
MACQUARIE UNIVERSITY'S RESEARCH NETWORK

FOR FURTHER INFORMATION
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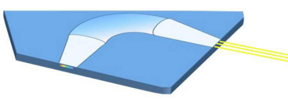
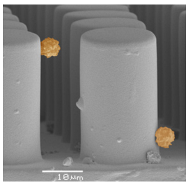
MQ Photonics areas of focus

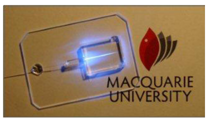
The seven frontiers of optical science on which *MQ Photonics* concentrates correspond to the research interests and expertise of its members. They define our strategies for current and future research in



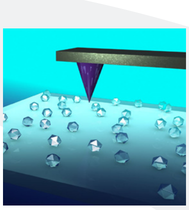
ASTROPHOTONICS – a rapidly emerging area that uses frontier technologies from physical, optical and photonic sciences to improve the power, utility and versatility of modern astronomical instruments and observational procedures. For instance, robotically micropositioned optical fibres have already revolutionised spectroscopic measurements from advanced astronomical optical telescopes. *MQ Photonics* researchers are developing new applications utilising fibre Bragg gratings, holographic imaging filters and gratings, and miniature photonic spectrographs. Fresh astrophotonic initiatives are expected to open up new frontiers for optical astronomy. This *MQ Photonics* initiative builds on close links with the nearby Australian Astronomical Observatory (AAO).



BIOPHOTONICS – exploits interactions between light and biological material in a wide variety of applications. The science of light can address many biological and medical challenges, both clinical and laboratory-based, with a diversity of approaches that include microscopy, imaging, spectroscopy, lasers, and fibre optics. Biophotonics is widely recognised as a key science/technology for the next generation of clinical tools and biomedical research instruments. Our researchers are involved in a diverse range of related projects including advanced bio-imaging using fluorescent nano-particles, creation of novel bio-chips based on microfluidic pathways and next-generation laser surgical methods.

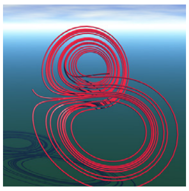


MICROPHOTONIC OPTICAL SYSTEMS – manipulate and control light on a microscopic scale and represent a major advance for lasers and optical technology. They include microstructured and photonic crystal fibres, as well as planar lightwave circuits or integrated optical devices (the optical equivalent of the silicon chip in electronics), with applications in telecommunications, biophotonics, sensing, medicine, quantum optics and primary industry. *MQ Photonics* researchers have been the first to demonstrate integrated waveguide laser and quantum photonic chips fabricated using novel direct write methods, and are currently pursuing more complex optical devices.

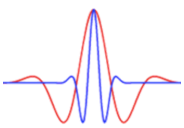


NANO-OPTICS AND NANOPHOTONICS – entailing interaction of light with tiny nanometre-scale structures. Such phenomena are influenced by quantum size effects of matter, and by the near-field properties of light. Efficient control of light on this scale, for instance by plasmonics, is a promising way to miniaturise next-generation photonic devices. Our researchers undertake both theoretical and experimental nano-scale research. Projects include fabrication of nano-diamonds and studies of their unique optical properties, and investigations of how energy is transferred between photons and matter and development of new devices that leverage of these insights.

OPTICAL SENSING AND IMAGING – relevant to areas such as biophotonics, the environment, community health and safety, defence, information retrieval, and entertainment. Ongoing research poses significant challenges for the physical and life sciences, medicine, engineering, and data processing. Our rsearchers are developing advanced optical sensing and imaging techniques based on confocal laser microscopy, fluorescence, surface plasmon resonance, flow cytometry, cavity ringdown and nonlinear-optical spectroscopy, supercontinuum generation, spectroscopy and imaging by terahertz waves, and spatial/spectral imaging by broadband light sources.



PHOTONIC SOURCES – such as lasers and associated nonlinear-optical devices, are essential components for most photonic systems, thereby facilitating advances in biomedicine, communications, materials processing, imaging, and optical sensing applications. The science and engineering of such sources of coherent light from the extreme ultraviolet to the microwave region continues to be the focus of much research and development. *MQ Photonics* innovations include: compact lasers producing coherent microwave-modulated radiation for communications, defence and radio astronomy; high-power fibre lasers; first-ever continuous-wave yellow Raman laser; high-performance tunable pulsed optical parametric oscillators for spectroscopy; and an efficient diamond laser.



ULTRAFAST LASER APPLICATIONS – employ pulses of coherent light as brief as a few femtoseconds, which is at the leading edge of present technological capabilities. Ultrafast lasers offer great potential for innovations and applications An outstanding problem that is being tackled by *MQ Photonics* researchers is to develop new types of ultrafast laser that are sufficiently compact, robust, reliable, and cost-effective for applications outside the laboratory. Particular applications include sensing and imaging of biological processes, fabrication of microphotonic devices by laser-induced microstructuring, and coherent generation of white-light supercontinua for spectroscopy and imaging.