MACQUARIE UNIVERSITY | MQ PHOTONICS RESEARCH CENTRE

NEWSLETTER

Issue 23 – 23 September 2009

MQ Photonics Newsletter is an informal internal publication of the ***MQ Photonics Research Centre*** <http://web.science.mq.edu.au/groups/mqphotonics/>.
We aim to distribute it by e-mail every 3 weeks. Please send copy to <lizb@physics.mq.edu.au> by 9 a.m. every 3rd Tuesday. **Next due date: Tue 13 October '09.**

Focal Points

ARC Future Fellowships – a success story for *MQ Photonics* ...

Five of the first 200 researchers to be awarded a prestigious 4-year fellowship under the Australian Research Council Future Fellowships scheme will be taking them up at Macquarie University. See: **www.arc.gov.au/ncgp/futurefel/ft_outcomes.htm**

Moreover, 2 of these 5 are MQ Photonics members: **Dr James Rabeau** and **Dr Richard Mildren** (the ones without ties in the adjacent happy snap). ►

Announcing the recipients, Senator Kim Carr, Minister for Innovation and Research, said that the scheme aims "to help retain Australia's best and brightest mid-career researchers."

Jim and Rich have kindly provided short articles on the research that they aim to do as Future Fellows working within MQ Photonics (see below).

Heartiest congratulations from us all!

www.staffnews.mq.edu.au/past_issues/past_stories/2009/macquarie_researchers_awarded_prestigious_arc_future_fellowships

Brian Orr

Dr James Rabeau: Room-temperature quantum microscopy for advanced nanoscale imaging

I am very pleased to have received a 2009 ARC Future Fellowship. The project builds on collaboration within the Department, other Australian institutes and internationally. I am looking forward to working with people to realise the proposal. The best thing in my biased view is that we've managed to get two projects up in Physics and both involving diamond! Rich and I like diamonds. There is a great culture of support in the Department and in *MQ Photonics*, and many generous and experienced people helped me in the process: Jason, Ewa, Brian, Mike and Louise Brown (from CBMS) most notably. Thanks a lot, and I hope that this cooperative culture keeps getting better and leads to more success with our research funding. Here is my project summary:

This project will develop a diamond-based "quantum microscope" for imaging single molecules. There are more atoms in a single cell than there are stars in the Milky Way and quantum microscopy has the potential to detect each and every atom in one cell. This could revolutionise biological and medical imaging much like the telescope revolutionised observational astronomy. This next generation imaging platform will break through the barriers of conventional optical and spin imaging and provide insights into protein structure and function at the level of single molecules. The advances made in the physical sciences to reach this goal will have even wider reaching impact on our understanding of matter interactions at the level of single quanta.

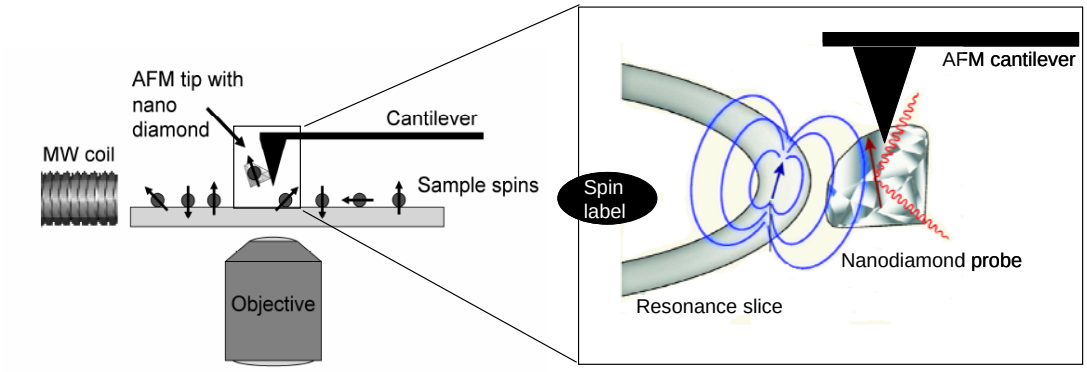
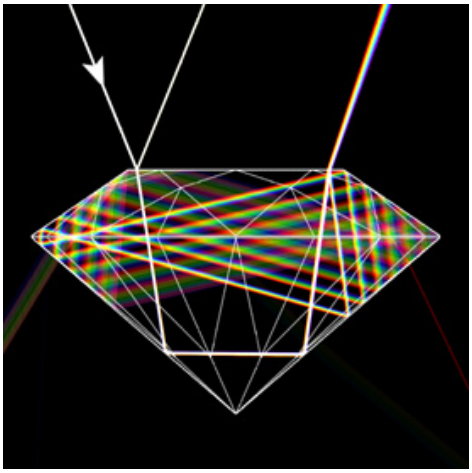


Figure 1: Schematic of the single spin imaging system. In this configuration, the sample would move from left to right and at each point the nanodiamond probe would "feel" a different spin which is optically registered and subsequently provides the final image of the sample. Figure 1 close up [adapted from Romalis, "Virtues of diamond defects", *Nature* **455**, 606 (2008)] shows how a magnetic field (spin label) creates a specific region (resonance slice) which induces optically detectable resonance in a NV probe, thereby enabling precise determination of the position of the label.

James Rabeau

Dr Richard Mildren:

Raman conversion in diamond: next-generation long- and far-infrared and terahertz lasers



The development of powerful and tunable lasers spanning the long wavelength infrared and extending into the so-called terahertz regions of the electromagnetic spectrum is one of the most pressing opto-electronic engineering challenges. The absence of practical alternatives to large-scale synchrotron and free electron laser facilities has hindered progress in many fields of science and technology, and in applications of national priority such as precision laser excising of cancers, detection of explosives and environmental mapping of greenhouse gases. The focus of this fellowship is to create and engineer tabletop sources that address these deficiencies by generating the long wavelength radiation via stimulated Raman scattering in diamond. Just as optical materials such as gallium arsenide, Nd:YAG, and silica have revolutionized photonics at visible and near infrared wavelengths, diamond holds similar promise at longer wavelengths owing to the recent advances in diamond synthesis and to its outstanding optical and physical properties that results from its closed packed, strongly bonded and highly symmetric lattice. Of particular relevance to this project is diamond's high Raman (laser) gain coefficient, high thermal conductivity and broad transmission at infrared and terahertz wavelengths (from 6 microns to more than 150 microns). The project aims to develop long wavelength sources that enable scientific breakthroughs in neurosurgery, defence-science and ultra-sensitive environmental sensing.

Richard Mildren

Engineering Excellence Awards – another success story for *MQ Photonics* ...

What a team! Kali Madden, Mick Withford, Martin Ams, Peter Dekker, Judith Dawes, Adam Strickland and Robert Williams dressed up and celebrating their success in the 2009 Engineering Excellence Awards.

Several MQPhotonics members enjoyed pleasant company and a great evening at Engineers Australia's 2009 Engineering Excellence Awards at the Westin Hotel in Sydney on Friday 18 September. This annual event celebrates excellence in a wide range of Engineering People and Projects from all over NSW, and has several categories: People in Engineering; Industry Awards; and Project Awards. Two entries from CUDOS at Macquarie in the Industry Awards category were "The Photonics Simulator" in the Education and Training section (team: **Sam Campbell**, **Adam Strickland**, **Robert Williams**, **Kali Madden**, **Nem Jovanovic**, **Ben Johnston** and **Judith Dawes**) and "Ultrastable, ultra-robust waveguide laser chip" (team: **Mick Withford**, **Martin Ams**, Graham **Marshall** and **Peter Dekker**) in the Innovations and Inventions section. Each entry was awarded Highly Commended in their respective sections. Furthermore, the Photonics Simulator team has been invited to develop a display for the Powerhouse Museum to be shown for a year. This exciting development is likely to promote our work to as many as half a million people!

Judith Dawes

ERA – a new era for reporting of research outcomes?

Some of us attended one of the seminars on Monday 21 September to inform us about the ARC's Excellence in Research for Australia (ERA) Initiative. See: **http://www.arc.gov.au/era/default.htm**

We are probably entitled to presume that we know a lot about ERA already, in view of our participation in the trial evaluation of the Physical, Chemical and Earth Sciences (PCE) cluster. But there is much more to come sometime in 2010 when the real thing (what ERA experts refer to as "The Big Bang") is launched. Meanwhile, we read that "ERA will assess research quality within Australia's higher education institutions using a combination of indicators and expert review by committees comprising experienced, internationally-recognised experts" and that it "will detail by institution and by discipline those areas that are internationally competitive, together with emerging areas where there are opportunities for development and further investment."

… and what were our "learnings" on Monday?

I can't speak for other people, but I did discover a new word that seems to be in vogue amongst the Canberra *cognoscenti* at present. The new word is "learnings," which seems always to be plural and to be synonymous with "information," "result," "outcome of an investigation" or even "take-home message." Their presentations on Monday were laced with many "learnings."

In fact, I had first come across this apparently new word in a scary article by Don Watson (PM Paul Keating's former speech-writer, now jargon-buster and perceptive author) in last Saturday's *Sydney Morning Herald*, at: http://www.smh.com.au/opinion/society-and-culture/vital-lessons-from-the-day-words-fell-short-20090918-fvfr.html . I thought that the article was scary because it explained how messages from the Victorian fire authorities had been so couched in official, obscure jargon that their "learnings" were quite incomprehensible to the people who ultimately lost their homes (and, in some cases, their lives) in the dreadful bushfires last February. One CFA manager was quoted as explaining the failure of communications as follows: "Of course, the learnings from these fires" ... "the scientists will come out and give us an outcome of what sort of messaging and where we can go to better inform communities …" Watson adds: "He and other managers talked a good deal about 'learnings', 'big learnings' and even 'huge learnings'." I rest my case!

On visiting *Yahoo!*, I found that the satirical character Borat claims to have written a book entitled "Cultural Learnings of America for Make Benefit Glorious Nation of Kazakhstan" and that there is a "Corporate Buzzword Dictionary" (motto: "where corporate buzzwords go to die") at http://learnings.org/ .

If there are/is any "learnings" from my ramblings, then they/it may be that we have to choose between *either* joining the corporate buzzword brigade if we want to understand what we are being told *or* rejecting such management jargon on principle ... and heaven help us if we choose the wrong option!

Brian Orr

Fresh vistas

Research funding opportunities – internal schemes

- MQ Strategic Infrastructure Scheme (MQSIS) – Research Infrastructure Block Grants (RIBG) ... due 23 Sep
- MQ Research Innovation Fund (MQRIF) ... due mid-November?

Research funding opportunities – external schemes

- NSST Research Support for National Security (RSNS) grants ... due 2 Oct
- ARC Linkage Projects (Round 2) for funding commencing July 2010 ... due 21 Oct
- ARC Centres of Excellence – *next round still to be announced* ... due late 2009?

Upcoming conference – ACOLS/ACOFT 09 (earlybird registration due 12 October)

More information: **http://www.plevin.com.au/acoftacols2009/**
Some (hopefully many) of us will have received paper acceptance letters in the last few days.

Upcoming conference – ICONN 2010 (abstract submission extended to 25 September 2009)

Deb Kane reminds us that the call for papers for ICONN 2010 (22-26th February 2010) is open. Deadline has been extended to 25th September. Note that an abstract of up to 2 pages is requested but a 1-page abstract is acceptable (template attached). An IEEE proceedings CD will be published (E1 papers) and a minimum 3 pages will be implemented for manuscripts to appear there. **http://www.ausnano.net/iconn2010/abstracts.php**

Publications

Recently accepted / in-press articles:

LA Stewart, Y Zhai, JM Dawes, MJ Steel, JR Rabeau, MJ Withford, "Single Photon Emission from Diamond nanocrystals in an Opal Photonic Crystal", *Optics Express*, (accepted 17th September 2009)

Abstract: We present the first optical measurement of a single nitrogen-vacancy (NV) center in a three-dimensional photonic crystal. The photonic crystal, fabricated by self-assembly of polystyrene microspheres, exhibits a photonic stopband that overlaps the NV photoluminescence spectrum. A modified emission spectrum and photon antibunching were measured from the NV centers. Time-resolved fluorescence measurements revealed a 30% increase in the source lifetime. Encapsulation of single NV centers in a three-dimensional photonic crystal is a step towards controlling emission properties of a single photon source.

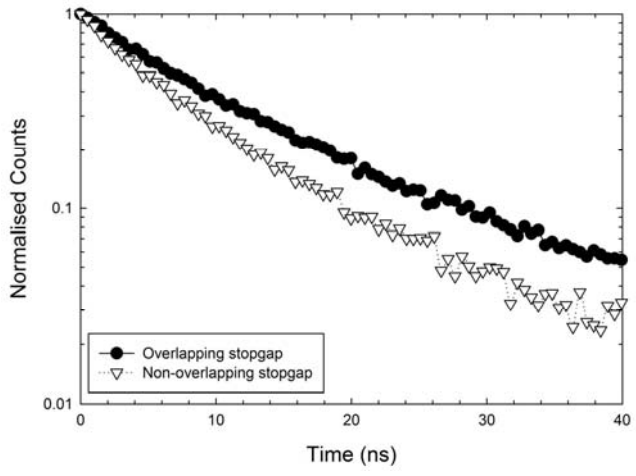


Fig. 4. Time-resolved fluorescence measurements of the NV centers inside opals. The data represented by solid circles is an average measurement of five different NV centers in an opal with a stopband positioned at 710 nm (overlapping the NV spectrum), and was found to have a lifetime of 13.3±0.8 ns. The data represented by open triangles is an average measurement of five different NV centers in an opal with a stopband positioned at 610 nm (non-overlapping), and was found to have a lifetime of 10.2±2.0 ns. The lifetime measurements were taken from NV center nanocrystals that displayed antibunching, and so contained one or few color centers. Note that the time indicated as t=0 is actually 11 ns after the excitation pulse. This removes any information from the laser pulse in the determination of the lifetime.

N Cvetojevic, **JS Lawrence**, SC Ellis, J Bland-Hawthorn, R Haynes, A Horton, "Characterization and on-sky demonstration of an integrated photonic spectrograph for Astronomy", *Optics Express*, (accepted 4th September 2009)

Abstract: We present results from the first on-sky demonstration of a prototype astronomical integrated photonic spectrograph (IPS) using the Anglo-Australian Telescope near-infrared imaging spectrometer (IRIS2) at Siding Spring Observatory to observe atmospheric molecular OH emission lines. We have succeeded in detecting upwards of 27 lines, and demonstrated the practicality of the IPS device for astronomy. Furthermore, we present a laboratory characterization of the device, which is a modified version of a commercial arrayed-waveguide grating multiplexer. We measure the spectral resolution full-width-half-maximum to be 0.75±0.05nm (giving R = λ/δλ = 2100±150 at 1500nm). We find the free spectral range to be 57.4±0.6nm and the peak total efficiency to be ~65%. Finally, we briefly discuss the future steps required to realize an astronomical instrument based on this technology concept.

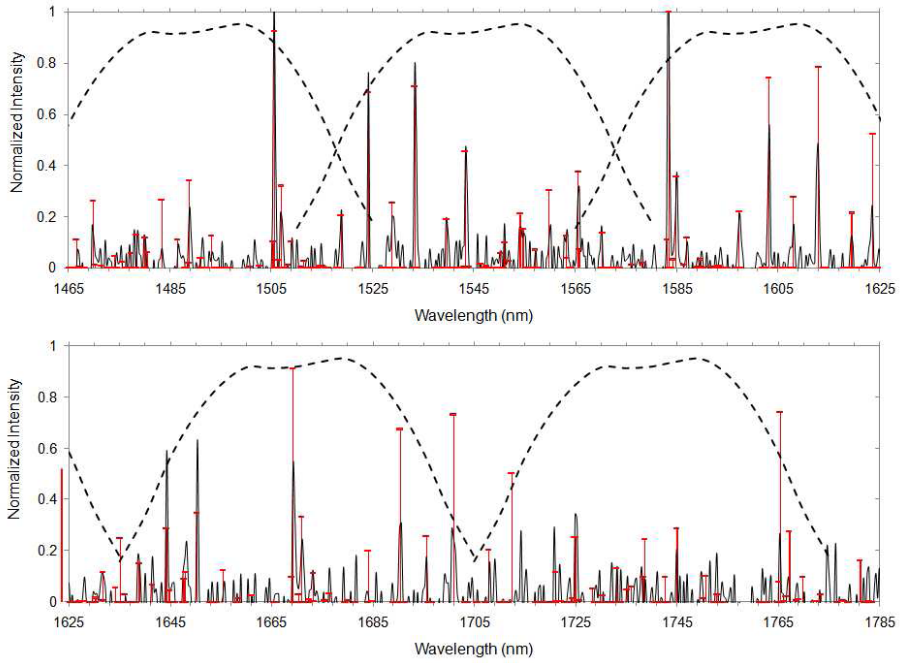


Fig. 5. The night sky OH spectrum (solid black lines) using the IRIS2 instrument as a crossdisperser for the IPS, superimposed with the theoretical [3] positions and strengths of the OH lines (red), and the diffraction efficiency envelop of the IPS for each order (dashed lines). The 23rd order is top left, which progresses to 27th order in the bottom right of the graph.

MQ Photonics Seminars:

Time: 12Noon, Wed 23rd September Place: C5C 498 **Zhen Song**

TOPIC: Characterization of optical properties and skin permeability of ZnO nanoparticle

ABSTRACT: ZnO nanoparticle (NP) is widely used in cosmetic formulations as efficient UV light absorber. The possibility that topically applied NPs penetrating the stratum corneum into deeper layers of human skin and diffuse further into the circulatory system have raised public concern. Since the capability of routine metabolic process of human being won't be sufficient to get rid of those NPs, uncertain hazardous will present. ZnO sized 30nm or larger have been claimed to stay mainly in the upmost layer of human skin or hair follicle. In our investigation, ZnO NPs of a broader size range, 3nm-100nm and different modification were applied to human and porcine skin, their permeability was studied by means of fluorescence scanning confocal and two-photon excitation microscopy. Meanwhile, SEM/EDX analysis system was applied to determine the elements concentration at different layer of NP treated skin. In order to quantify ZnO signal on the autofluorescence background of skin and second harmonic signal of collagen, the linear and nonlinear optical properties of ZnO NP were characterized. A blue shift due to the quantum confinement effect of the ZnO NP was observed. The linear and nonlinear absorption cross-sections and quantum yield of ZnO NPs were determined by its quantitative comparison with the tabulated parameters of the organic laser dyes.

Time: 12Noon, Wed 30th September Place: C5C 498 **Wei Deng**

TOPIC: Enhanced Flow Cytometry Based Bead Immunoassays by Using Metal Nanostructures

ABSTRACT: While the principle of fluorescence enhancement of metal nanostructures is well known, the utility of this effect in practical methodologies used in analytical laboratories remains to be established. In this work we explore the advantage of fluorescence enhancement for flow cytometry. We report the observation of metal-enhanced fluorescence emission of fluorophores located on the surface of silica beads coated with nanostructured silver, suitable

for flow cytometry detection. The fluorescence enhancement was investigated using a model AlexaFluor 430 IgG immunoassay and AlexaFluor 430 labeling. Approximately 8.5-fold and 10.1-fold higher fluorescence intensities at 430 nm excitation were, respectively, observed from silvered ~ 400 nm and 5 µm silica beads deposited on glass as compared to the control sample. The 400 nm and 5 µm beads were compatible with flow cytometry readout, although lower enhancement factors of 3.0 and 3.7 were obtained. We show that such values are consistent with less favourable overlap of the plasmon resonance in silver nanostructures with 488 nm excitation wavelength used in the flow cytometry experiment.

Time: 12Noon, Wed 21st October Place: C5C 498 **Carlo Bradac**

TOPIC: TBA

ABSTRACT: TBA

People and Progress

MQ Photonics Marathon Man ...

Congratulations to **Carlo Bradac**, who finished 183rd out of all 2456 finishers in the Sydney Marathon 2009 last Sunday, 20 September. Carlo "did pretty well" (his own words), finishing in a net time of 3h 20' 49"; this placed him 24th in his category (male, aged between 25–29).

Carlo writes that he hopes that "this helps to motivate the *MQ Photonics* sporting spirit"!

Brian Orr

Macquarie University OSA Student Chapter

Our recent 'Hot Pizza, Hot Photonics' event passed successfully last week, with **Doug Little** delivering informative insights into prominent optics research topics such as surface plasmon lasers, swine flu detection through optics and the Giant Magellan Telescope project. While undergraduate numbers were less than anticipated (we suspect due in part to the NTEU strike), there was no shortage of OSA Chapter members to polish off the pizza. This talk was pitched at a very appropriate technical level for both post- and under-graduates alike and as a result, will most likely make regular appearances in our programme of events both here at Macquarie and further afield.

Our Lab Scheme for undergraduates has finally gotten underway this last fortnight. With OH&S requirements successfully completed, our undergraduate participants will be joining **Doug Little** and **Nem Jovanovic** in their respective waveguide refractive index profilometry and fibre Bragg grating projects. All parties seem enthusiastic at this point and we are looking forward to some good feedback as the scheme progresses through the following weeks.

The Macquarie University OSA Student Chapter has recently acquired an email account from ScienceIT so we invite all future communications to be directed to MQOSASC@science.mq.edu.au

Macquarie University OSA Student Chapter Mini Soccer Tournament

Date: Friday 23 October Time & place: 1-4pm, at the outdoor soccer/basketball courts near the gym

We are aiming to get small teams of 4-5 people or so to play several short games in a round-robin style tournament. Both staff and students are encouraged to participate in what should be an enjoyable event. There are limited positions available so if you are interested in playing please let Josh Toomey know by email (jtoomey@science.mq.edu.au) by 2nd October at latest

Alex Butler