IONS®-KOALA 2014

Program and Abstracts

23-28 November
Adelaide, Australia

THE UNIVERSITY *of* ADELAIDE

UofA OSA Student Chapter

OSA® The Optical Society

IONS®-KOALA is organised by OSA student chapters each year and is completely not-for-profit. In order to encourage attendance by the greatest number of students possible, the conference covers the cost of all student accommodation and meals while aiming to make registration and attendance affordable.

This would not have been possible without the support provided by our generous sponsors. On behalf of the IONS-KOALA 2014 organising committee and all KOALA attendees, a huge thank you for all your support!

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Welcome Address

Greetings to you, and welcome to our beautiful city of Adelaide!

In 2014, the IONS®-KOALA Conference is based the University of Adelaide campus, home to the international research centres of the Institute of Photonics and Advanced Sensing, the ARC Centre for Nanoscale BioPhotonics, as well as eight other institutes and centres of excellence.

The KOALA '[C]onference on Optics, Atoms and Laser Applications' is supported by the International OSA Network of Students (IONS) and brings together students, researchers, industry and institute representatives, and international delegates from eight countries. The emphasis of this instalment of KOALA is brought to us by our plenary speakers, with talks on the world of ultrafast optics, novel attosecond phenomenology, precision measurement of universal constants, and gravitational wave detection.

This year also sees the introduction of the Industry Workshop: a networking and presentation evening involving key industries in the photonics sector. In the spirit of collaboration, we hope to foster an environment for scientists to support each other, relax together and form new ideas. There will be laboratory tours, poster and scientific photography competitions, and lots of relaxing social time. This year's Social Day excursion is to McLaren Vale's Serafino Winery which includes a delicious menu for our Conference Banquet.

Thank you to our plenary speakers, our sponsors and our attendees. We hope you enjoy your stay!

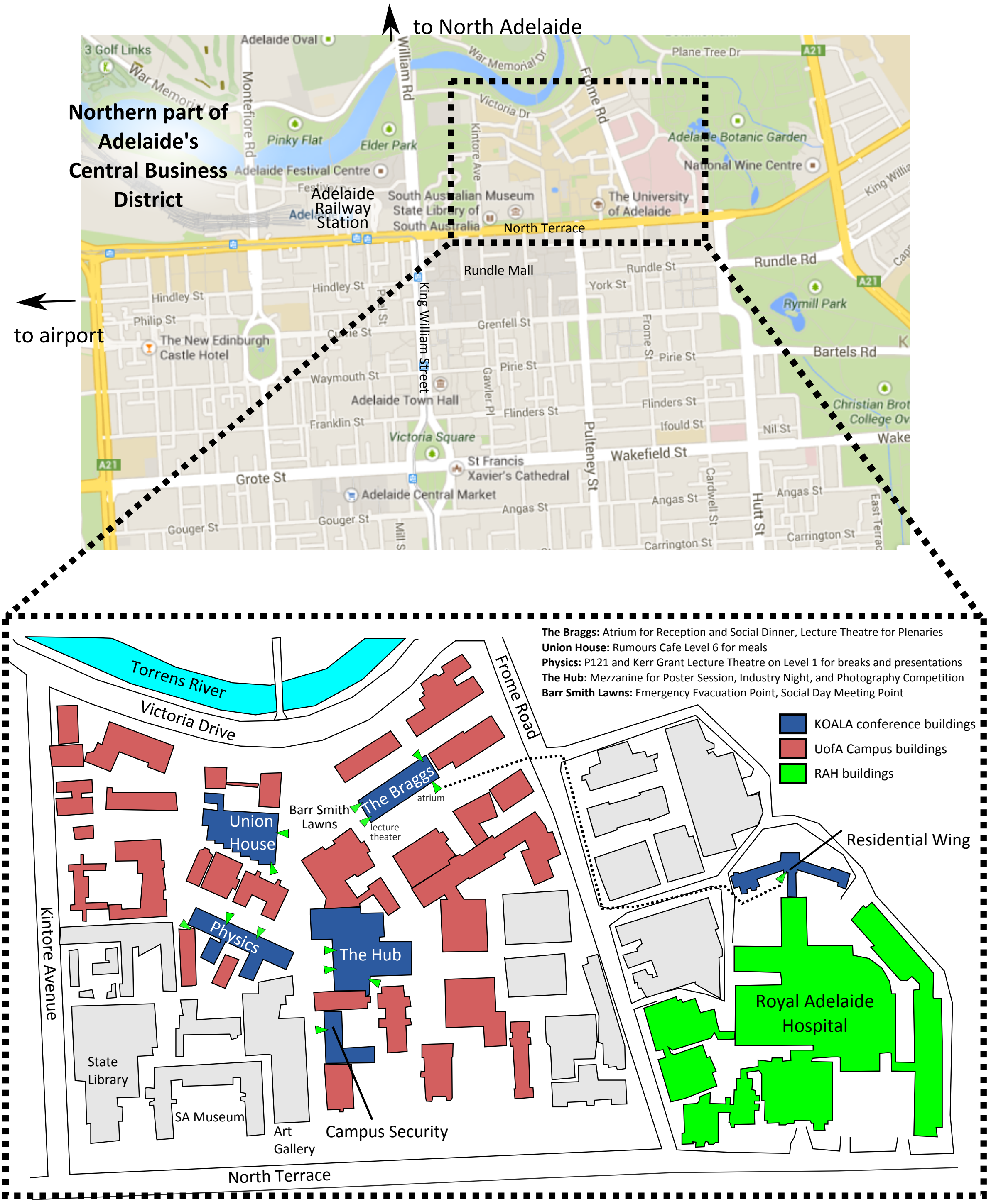
On behalf of the IONS®-KOALA 2014 organising committee

Jonathan Hall
IONS-KOALA 2014 Chair
University of Adelaide OSA Student Chapter

KOALA Organising Committee Members

Chair	Jonathan M. M. Hall
Sponsorship	Sebastian Ng
Treasurer	Ka Wu
Committee members	Myles Clark Ori Henderson-Sapir Sophie Hollitt Eleanor King Fiorina Piantedosi Patrick Tapping

Map



The Braggs: Atrium for Reception and Social Dinner, Lecture Theatre for Plenaries
Union House: Rumours Cafe Level 6 for meals
Physics: P121 and Kerr Grant Lecture Theatre on Level 1 for breaks and presentations
The Hub: Mezzanine for Poster Session, Industry Night, and Photography Competition
Barr Smith Lawns: Emergency Evacuation Point, Social Day Meeting Point

🟦 KOALA conference buildings
🟥 UofA Campus buildings
🟩 RAH buildings

A tourist map of Adelaide including local attractions is also included in the Conference Bag.

If you have internet access, visit http://ions-koala2014.osahost.org/web-app for an interactive conference schedule and map.

Travel in Adelaide

The IONS®-KOALA 2014 Conference and Accommodation are located on the north side of Adelaide's Central Business District (CBD), a short walk from Rundle Mall and King William Street. Rundle Street and Rundle Mall have a large variety of restaurants and shops, located just one street away from the Royal Adelaide Hospital (RAH) accommodation. Other parts of the CBD and North Adelaide are easily accessible by walking, or by using free public transport. It's free to use the tram to travel within the CBD, and also free to use the loop buses 98C and 99C to travel around the CBD and North Adelaide.

Public transport is readily available for visiting other parts of Adelaide, and can be paid for with cash or with a MetroCard. MetroCards are available for visitors from the Adelaide Railway Station, or the Adelaide Metro InfoCentre at the intersection of King William Street and Currie Street.

Accommodation

Accommodation is provided at the Royal Adelaide Hospital (RAH) Residential Wing, as shown on the map. Some KOALA Committee members will be staying at the accommodation - if you have any concerns or questions, please let your Committee members know.

The KOALA organising committee is responsible for base accommodation costs only - all other costs (if any) are your responsibility. Please note the following accommodation rules:

- The RAH Residential Wing has a No Smoking Policy.
- Room Keys are only to be used by the person allocated to the room, and may not be given to anyone else.
- Attendees and visitors **MUST** check in with Reception every time they enter or leave the building. This is required in case of an emergency situation.
- No kettles, toasters or irons are allowed in the bedrooms. Bicycles are not permitted in the building.
- **DO NOT** use aerosol deodorants or other aerosol cans in the bedrooms – it can set off the fire alarms.
- Please keep your room and wardrobe locked at all times. Report any theft or other legal activity to the Receptionist and/or a KOALA Committee member and/or the police.

The following facilities are available at the RAH:

- A community lounge, kitchen, bathroom and laundry are available on every floor.
- Coin telephones are available on levels 4 and 8. Phone cards can also be obtained from the receptionist between 7:30 am and 9:00 pm.

- Cleaning tools are available in the laundry. An iron is available from the Reception for a $20 deposit.
- A computer room is available with internet access - check with Reception regarding computer availability.
- Soiled linen can be exchanged for fresh linen at the Linen room on Level 1 between 8:00 am and 11:00 am. Leave linens in your room on the last day.
- The Cafeteria in the Robert Gerard Wing of the hospital is open all day for snacks and drinks.
- Sharps disposal containers can be obtained at the Reception.

Contact Details

RAH Residential Wing Reception		(+61 8) 8222 5169
KOALA Committee Support at the RAH	Sophie Hollitt	(+61) 431 837 990
	Patrick Tapping	(+61) 410 748 297
	Ka Wu	(+61) 425 531 311
	Ori Henderson-Sapir	(+61) 403 119 776
	Catherine Lang	(+61) 437 057 629
University of Adelaide Campus Security	Enquiries	(+61 8) 831 35990
	Emergency	(+61 8) 831 35444
KOALA Committee Emergency Contacts	Sophie Hollitt	(+61) 431 837 990
	Sebastian Ng	(+61) 422 016 681
	Patrick Tapping	(+61) 410 748 297
	Ka Wu	(+61) 425 531 311

Emergency Details

In case of an emergency threatening your life or the life of another, get to a phone and **call 000** to request police, fire, or ambulance. If you are calling from an internal University of Adelaide phone, dial 0 first to obtain an outside line. If you are calling from a mobile phone, you will need to tell the operator your location - make sure you are familiar with the name of your location whenever you visit somewhere new.

After the emergency services have been called, follow any instructions you are given, and call one of the contact numbers above for a KOALA Committee member to inform them of the emergency.

For non-life-threatening emergencies, call Campus Security (+61 8 831 35444) when at the University of Adelaide, or contact a KOALA Committee member to ask for assistance.

In the event a University of Adelaide building needs to be evacuated, the emergency assembly point is the Barr Smith Lawns (between The Braggs building and Union House).

Internet Access

Wireless internet access is available around the University of Adelaide via the Eduroam system. Eduroam allows users from participating institutions to gain secure access to wireless network access using their standard username (email format)/password credentials as they do at their home institution for wireless access. We recommend testing Eduroam at your home institution before you visit the University of Adelaide.

Additionally the Adelaide City Council provides free internet access around parts of the Central Business District and North Adelaide under the "AdelaideFree" name.

Media

Keep up to date on the conference by following us on our twitter account @IONS_KOALA_2014 and feel free to use the hashtag #ionskoala2014 if you tweet. These will be great for keeping track of your friends during social evening activities at off-campus venues.

We've also created a webapp with the conference program and maps of where you need to go. To use this, visit http://ions-koala2014.osahost.org/web-app or scan our QR code.

Information for Oral Presentations

For those giving a talk at the conference, you have been allocated a day and timeslot. The schedule for the talks is listed in the Contents section and includes day, time, name and abstract for everyone who is presenting a talk. Timeslots are 20 minutes each, which should be comprised of a 15 minute talk with up to 5 minutes allowed for audience questions and changeover. Be warned that Bad Things^{TM} may happen to people who run overtime.

A Windows PC with internet access will be provided. You *must* load and test your slides on this computer *prior to the session* you are speaking in — using your own personal computer is not permitted. Please arrive at the lecture theater during the tea break before your presentation slot, in order to transfer your files.

The computer will accept PDF and MS Powerpoint slide formats which we suggest to be in a 4:3 "square" aspect ratio (rather than 16:9 widescreen). A laser pointer and a presentation remote will be provided.

Information for Poster Session

For those presenting a poster, you will need to set up your poster prior to the event. Bring your poster to the Hub Mezzanine at 5:30 pm on Monday, where exhibition boards will be available for you to affix your poster.

There are no formally allocated spaces for presenters, so positions will be determined on a first–come–first–served basis. The boards will be a fabric style suitable for use with "Velcro" type hooks. It is recommended you obtain your own hook tape or similar prior to the event, as we cannot guarantee that we can provide everyone with this.

The presentation session will start at 7:00 pm, immediately after dinner and run until 9:00 pm. You will be required to be nearby your poster during the entire session to discuss your work with other attendees.

After the session, you will be responsible for the care of your poster. You *may* leave your poster attached to the boards, which will be packed away at the venue, however you *must* collect your poster off the boards before lunch on Thursday. If your poster is not collected before this time, the Organising Committee cannot guarantee its safety.

Conference Schedule

	Sunday 23rd	Monday 24th	Tuesday 25th	Wednesday 26th	Thursday 27th	Friday 28th
7:30 AM		Breakfast *Rumours Cafe*	Breakfast *Rumours Cafe*	Breakfast *Rumours Cafe*	Breakfast *Rumours Cafe*	Breakfast *Rumours Cafe*
8:00 AM						
8:30 AM						
9:00 AM		Welcome and Plenary **Andre Luiten** *Braggs Lecture Theatre*	Plenary **Peter Delfyett**	Social Day and Conference Banquet *McLaren Vale* *(Meet on the Barr Smith Lawns)*	Plenary **Peter Veitch**	Plenary **John Tisch**
9:30 AM						
10:00 AM		Morning Tea - *Physics 121*	Morning Tea - *Physics 121* Presentation Tu1.1 - *Kerr Grant*		Morning Tea - *Physics 121* Presentation Th1.1 - *Kerr Grant*	Morning Tea - *Physics 121* Presentation F1.1 - *Kerr Grant*
10:30 AM		Presentation M1.1 - *Kerr Grant* Presentation M1.2	Presentation Tu1.2		Presentation Th1.2	Presentation F1.2
11:00 AM		Presentation M1.3	Presentation Tu1.3 Presentation Tu1.4		Presentation Th1.3 Presentation Th1.4	Presentation F1.3 Presentation F1.4
11:30 AM		Presentation M1.4 Presentation M1.5	Presentation Tu1.5		Presentation Th1.5	Presentation F1.5
12:00 PM		Presentation M1.6	Presentation Tu1.6		Presentation Th1.6	Presentation F1.6
12:30 PM		Lunch *Rumours Cafe*	Lunch *Rumours Cafe*		Lunch *Rumours Cafe*	Lunch *Rumours Cafe*
1:00 PM	Registration *Braggs Atrium*					
1:30 PM		Presentation M2.1 - *Kerr Grant* Presentation M2.2	Presentation Tu2.1 - *Kerr Grant* Presentation Tu2.2		Presentation Th2.1 - *Kerr Grant* Presentation Th2.2	Presentation F2.1 - *Kerr Grant* Presentation F2.2
2:00 PM		Presentation M2.3	Presentation Tu2.3		Presentation Th2.3	Presentation F2.3
2:30 PM		Presentation M2.4 Presentation M2.5	Presentation Tu2.4 Afternoon Tea - *Physics 121*		Presentation Th2.4 Presentation Th2.5	Presentation F2.4 Presentation F2.5
3:00 PM		Afternoon Tea - *Physics 121*	Presentation Tu3.1 - *Kerr Grant*			Closing Address - *Physics 121*
3:30 PM		Presentation M3.1 - *Kerr Grant* Presentation M3.2	Presentation Tu3.2 Presentation Tu3.3		Scientific Photography Competition *Hub Mezzanine*	Lab tours *Braggs Building*
4:00 PM		Presentation M3.3	Presentation Tu3.4			
4:30 PM		Presentation M3.4 Presentation M3.5				
5:00 PM			Industry Night *Hub Mezzanine*			
5:30 PM		Poster set-up time - *Hub*			Prize Presentation	
6:00 PM	Dinner and Reception *Braggs Atrium*	Dinner *Rumours Cafe*		Dinner *Rumours Cafe*	Conference Dinner BBQ *Braggs Atrium*	Informal Dinner *TBA Local Venue*
6:30 PM						
7:00 PM		Poster Session *Hub Mezzanine*	Dinner *Rumours Cafe*	Social night *Wheatsheaf Hotel* *(Meet on the Barr Smith Lawns, catch Tram to venue)*		
7:30 PM						
8:00 PM						
8:30 PM						
9:00 PM						

Registration and Reception

The registration desk will be open on Sunday from 1:00 pm to 6:00 pm at the Braggs Building ground floor atrium. Conference bags and identification lanyards will be issued to all registered attendees. Please wear your lanyard at all official KOALA events so the conference organisers, security and other attendees can easily recognise you during the conference.

Following registration on Sunday, a Reception will be held to open the conference and welcome attendees. This will be a casual event held at the Braggs Building ground floor atrium, with pizza and drinks provided from 6:00 pm. The Reception is a great opportunity to meet your fellow attendees who will be your company for the next week! For those wishing to socialise further after this event we will convene at a nearby pub.

Meals

Most meals will be served at Rumours Cafe on Level 6 in Union House.

Breakfast:	Monday to Friday
Lunch:	Monday, Tuesday, Thursday and Friday
Dinner:	Monday, Tuesday, Wednesday

The other meals included in the conference are the welcome reception on Sunday evening and the social barbecue on Thursday night. Attendees who registered for the Social Day will receive lunch as part of the excursion. Morning and afternoon tea breaks will be held in the Physics Building Room 121.

Oral Presentations

All plenary speakers will be presenting the first talk of the day in the Braggs Lecture Theatre. Following morning tea, all remaining student talks will be held in the Kerr Grant Lecture Theatre on the first floor of the Physics building.

▷ *For those presenting a talk, see the information for presenters in the previous section.*

Poster Session

The poster presentation session will be held after dinner on Monday evening at 7:00 pm in the Hub Mezzanine, level 5. Posters will be on display from those who have elected to present posters at the conference, who will also be available to discuss their work. This is a friendly, informal way to network and discuss ideas with fellow researchers over some drinks and nibbles. Following the conclusion of this session at 9:00 pm, the committee have chosen a local pub for further socialisation.

▷ *For those presenting a poster, see the information for presenters in the previous section.*

Industry Night Workshop

Industry Night is intended to be an opportunity for networking between conference attendees and representatives from the Australian optical community. The venue for this event is the Hub Mezzanine, level 5, starting at 5:00 pm directly after the conclusion of the student talks on Tuesday.

The formal proceedings will consist of short presentations from some of the business and research organisations, whose generous donations have made the conference possible. These will be interspersed with time for casual discussions over drinks and nibbles, followed by dinner at 7:00 pm.

We encourage all attendees to use this as an opportunity to find out about those organisations that work in the field of optics and lasers. These organisations will likely be a source of employment for graduates, homes for future researchers, or suppliers of parts, services and equipment used throughout your future career. Please remember that the Industry Representatives don't bite! If you feel nervous about speaking to them, there will be some ice-breaking topics on the night to help start conversations.

Again, those wishing to socialise after dinner are invited to a nearby pub.

Social Day/Conference Luncheon

Wednesday is set aside for a trip to the iconic wine region of South Australia, McLaren Vale. There we will visit the Serafino winery, where our hosts will serve us with a three–course lunch while we present the Poster Session prize, and all of our Travel Grant awards. Tours of the winery including wine tasting will be available for those who are interested.

Please be at the Barr Smith Lawns at 9:00 am sharp to board the buses — we won't be able to wait for anyone who is running late! We will be boarding the buses in front of Gate 9 Victoria Drive, just north of the Barr Smith Lawns. We will return to Adelaide for the usual dinner arrangements, where we can meet up with anyone who chose to explore Adelaide in their own way. Anyone who wants to continue to socialise should meet at the Barr Smith Lawns at 9:00 pm for a short walk and tram-trip to the Wheatsheaf Hotel, where the KOALA Committee is putting on a limited tab.

The tram trip to the Wheatsheaf Hotel is free: catch the tram from Rundle Mall or the Adelaide Railway Station towards the Entertainment Centre. Please keep in mind that the last tram back from the Entertainment Centre is at 12:30am: if you miss it, it's a 50 minute walk back to the RAH.

Photography Exhibition

This will be the second UofA OSA Student Chapter Photography Exhibition, and we're proud to make it part of IONS®-KOALA 2014. The exhibition will feature a variety of entries from staff and students at the University of Adelaide, as well as some KOALA attendees. The gallery will be open in the Hub Mezzanine from 3:30 pm, with five $100 prizes awarded around 5:30 pm. One of these prizes is the People's Choice Award, so make sure to vote for your favourite.

Social Dinner

Following the photography competition, the usual dinner will be replaced by a casual event at the Braggs Building ground floor atrium. We will fire up the barbecues and hopefully enjoy a beautiful warm Adelaide evening. At the conclusion of the event, we will again invite attendees to a nearby pub for the final night of the conference.

Lab Tours

The closing and farewell address will be held after lunch on Friday, which will mark the close of formal proceedings and the official end of IONS®-KOALA 2014. Following this, however, there will be an opportunity for interested attendees to visit some of the laboratories around the University of Adelaide. Further information will be provided at the farewell address.

Plenary Speakers

Professor Andre Luiten

Andre Luiten received his PhD (Distinction) in Physics in 1997 from the University of Western Australia (UWA). Professor Luiten won both the Bragg Medal from the Australian Institute of Physics as well as the Western Australian Premier's Prize for Early Achievement in Science for his early research work based around the construction of the world's best clock. Following his PhD, Andre has been awarded three Australian Research Council fellowships to pursue his research interests.

He recently moved state to take up two wonderful opportunities: Chair of Experimental Physics and the Deputy Director of the Institute for Photonics and Advanced Sensing (IPAS) which are both at the University of Adelaide. Prof. Luiten has authored more than 85 journal papers in his career as well as attracting more than $13M of funding from Australian, UK and USA sources.

His current interests cross many different fields but with the central attribute that precision measurement is exploited to learn new facts about the Universe or deliver a new capability that can enhance life. For example, he is building high performance microwave oscillators and lasers for applications in radar, timing, navigation and precision measurement. He is also developing new ways to deliver this accurate time through optical fibre to support radio-astronomers and others that need synchronization or accuracy in the field. One of his newest interests is using unique laser tools (called frequency combs) to measure the molecular content in a gas sample – this has applications in disease diagnosis by looking at the exhaled breath of a patient as well as industrial applications in looking for contaminants in various processes. A recent breakthrough was developing the means to measure temperature with sensitivity in the billionths of a degree.

Dr. Peter Delfyett

Peter Delfyett received his Ph.D. in electrical engineering from The City University of New York. After obtaining his Ph.D., he joined Bell Communication Research as Member of the Technical Staff. Dr. Delfyett joined the faculty at CREOL in 1993, where he is Trustee Chair Professor of Optics & Photonics at CREOL The College of Optics and Photonics, University of Central Florida. His technical expertise is in the area of ultrafast photonics, in the generation, transmission, detection and application of ultrafast optical pulse trains for applications in communications, signal processing, manufacturing and imaging. Dr. Delfyett was Editor-in-Chief of IEEE Journal of Selected Topics in Quantum Electronics, Associate Editor of IEEE Photonics Technology Letters, and Editor of IEEE LEOS Newsletter. He is a Fellow of the National Academy of Inventors (NAI), OSA, IEEE, APS and has served as member of the OSA Board of Directors, the Board of Governors of IEEE-LEOS and President of NSBP. Dr. Delfyett is the recipient of the NSF PECASE Award, the APS Edward Bouchet Award, the 2014 Medalist of the Florida Academy of Science, and the UCF Pegasus Professor Award, the highest honor awarded by the University. Dr. Delfyett has over 700 articles/presentations, and has been awarded 37 US patents. He also helped found Raydiance Inc., which manufactures the world's first software-controlled ultrashort pulse laser systems for industrial manufacturing and research.

Professor John W. G. Tisch

John W.G. Tisch is a Professor of Laser Physics at the Blackett Laboratory, Imperial College London. His research interests are ultrafast laser physics and high-intensity laser-matter interactions, especially the generation and application of high-power femtosecond laser pulses to generate coherent x-ray pulses of attosecond duration. He is a recognised world-authority on High Harmonic Generation (HHG) and Attosecond Science and Technology and joint founder of the UK Attosecond Programme. Tisch has been an elected member of the Commission on Atomic, Molecular, and Optical Physics of the International Union of Pure and Applied Physics, and has also served on a number of international conference committees, including High Field Short Wavelength and CLEO. He was one of the Founding Chairs of the international conference series "Ultrafast Dynamical Imaging of Matter" and has served as Joint General Chair for the conference Ultrafast Optics IX. He is a member of the international Scientific Advisory Committee for the Extreme Light Infrastructure (ELI) European project and a Fellow of the Institute of Physics. He has dual Swiss and Australian nationality and is married with two children. In his spare time he enjoys competitive running, cycling, tennis, carpentry and playing trumpet and piano.

Associate Professor Peter Veitch

Peter Veitch received his PhD degree from the University of Western Australia in 1987. After a brief post-PhD sojourn at UWA where he continued research into cryogenic resonant-bar gravitational wave detectors, he moved to the University of Glasgow in 1989 to work on the development of a prototype laser-interferometric gravitational wave detector. In 1992, he joined the Department of Physics at The University of Adelaide on a fixed-term teaching contract and became part of the Optics group. He is also a founding member of the LIGO Scientific Collaboration (LSC), and currently a member of the LSC Council and Chair of the Australian Consortium for Interferometric Gravitational Astronomy (ACIGA). His current research interests include

- The development of advanced and next-generation gravitational wave interferometers (GWI), with particular emphasis on wavefront distortion and compensation within the interferometer.
- The development of high-power CW and pulsed near-IR solid-state lasers for GWI, methane differential absorption lidar, coherent laser radar, and frequency-shifting into the mid-IR.
- Applications of Hartmann wavefront sensors to high sensitivity characterization of reflective and transmissive optics, and for single-pulse profiling of pulsed laser beams.

Contents

Phase-Locked, Chip-Based, Cascaded Stimulated Brillouin Scattering

Thomas F. S. Büttner[1], Irina V. Kabakova[1], Moritz Merklein[1], Darren D. Hudson[1], Duk-Yong Choi[2],
Barry Luther-Davies[2], Stephen J. Madden[2], and Benjamin J. Eggleton
thomasb@physics.usyd.edu.au

[1] Centre for Ultrahigh bandwidth Devices for Optical Systems (CUDOS), Institute of Photonics and Optical Science (IPOS), School of Physics, University of Sydney, NSW, 2006, Australia
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Compact, frequency-comb sources with GHz repetition rate are desirable for a number of important applications including arbitrary waveform generation, high speed analog-to-digital conversion and high resolution spectroscopy. In practice, however, compact frequency comb sources with GHz repetition rates are difficult to attain. Recently, a novel method for generating frequency combs with ~10GHz repetition rates was demonstrated using a nonlinear Fabry-Perot fiber resonator [1]. In Ref. [1] the frequency combs were generated via the interplay of two nonlinear optical effects in the resonator: Stimulated Brillouin Scattering (SBS) and Kerr-nonlinear four-wave mixing (FWM). In the described configuration, SBS determined the frequency spacing of the comb components whereas FWM ensured phase-locking of the frequency comb.

Here, we report for the first time generation of phase-locked frequency combs via the interplay of SBS and FWM on a photonic chip. A 6.5cm long rib waveguide consisting of As_2S_3 chalcogenide glass was used as a FP resonator. Feedback was provided by the reflections from the waveguide facets and an on-chip Bragg-grating. Phase-locking of the comb was confirmed by real-time measurements of the comb showing stable trains of 40ps pulses at 7.5GHz repetition rate.

Reference: [1] T. F. S. Büttner, I. V. Kabakova, D. D. Hudson, R. Pant, C. G. Poulton, A. C. Judge, and B. J. Eggleton, Sci. Rep. **4**, 1 (2014).

Graphene mediated electrical control of energy flow from an emitter

M. Badioli[1], K-J. Tielrooij[1]
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The ability to manipulate the spontaneous emission of an emitter such as a molecule, a quantum dot or a rare-earth ion is of interest in different fields, from light harvesting to quantum information processing and optical communication. Tailoring the spontaneous emission of an optical emitter relies on the modification of the emitter environment, denoted by the local density of optical states (LDOS). To this end, nanocavities, photonic crystals or plasmonic nanoantennas are generally used. In such systems, direct control of the emitter lifetime can only be achieved varying their position with respect to the LDOS-changing medium, thus being slow and technologically demanding.

Here[1] we combine erbium emitters and graphene in a hybrid system to demonstrate in-situ tuning of Er^{3+} ion emission by electrically adjusting the graphene Fermi energy by means of electrostatic gating. We measure fluorescence and lifetime of the Er^{3+} ions while varying the gating applied to the graphene, achieving full control over the energy flow from the emitter. We are able to electrically tune the Er^{3+} relaxation, that can occur via excitation of electron-hole pairs in graphene (for low Fermi energy), via free space photons (for intermediate Fermi energy) and via launching of graphene plasmons (for high Fermi energy). We find good agreement between a model of the gate-controllable LDOS and the experimental findings. Our work paves the way to the development of integrated optoelectronic devices at the nanoscale.

---

[1] K. J. Tielrooij, L. Orona*, A. Ferrier*, M. Badioli*****, G. Navickaite, S. Coop, S.Nanot, B. Kalinic, T. Cesca,L. Gaudreau, Q. Ma, A. Centeno, A. Pesquera, A. Zurutuza, H. de Riedmatten, P. Goldner, F. J. Garcia de Abajo, P. Jarillo-Herrero, F. H. L. Koppens, “Electrical control of optical emitter relaxation pathways enabled by graphene". Under review. *****equally contributing authors.

Refractive index sensing in silicon nanodisks and nano-heptamers

Katie E.Chong[1], Henry Orton[1], Isabelle Staude[1], Andrey E. Miroshnichenko[1],
Manuel Decker[1], Dragomir N. Neshev[1], Igal Brener[2], and Yuri S. Kivshar[1]
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By measuring the optical transmittance of arrays of silicon nanodisks and nano-heptamers embedded in various refractive index (RI) optical oils, we experimentally show that the spectral position of their resonance is sensitive to changes in the RI of the surrounding medium. The Mie type resonances in these nanostructures are shown to have sensitivities comparable to or better than those of plasmonic particles. Fig. 1 shows that, with an increase in the RI of the surrounding medium, the resonance positions of the nanodisks and the nano-heptamers shift by 368nm/RIU and 174nm/RIU, respectively. We furthermore conduct a proof-of-concept experiment showing that these non-toxic high-RI all-dielectric nanoparticles are good candidates for biosensing applications.

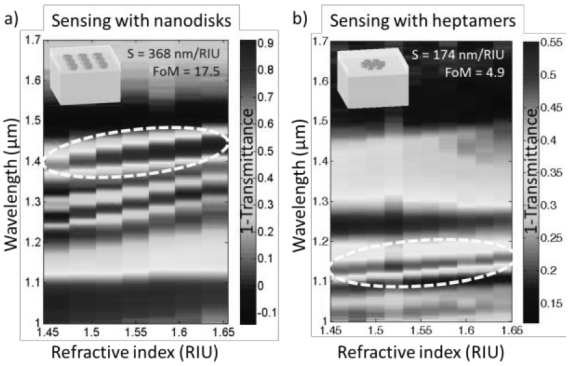

Figure 1: RI sensing with arrays of silicon a) nanodisks and b) heptamers. The insets show the schematics of the respective structures embedded in optical oils on a glass substrate. The colourmaps show the transmittance profiles of the two structures, with resonances (circled) shifting at a) 368nm/RIU and b) 174 nm/RIU with increasing RI.

High-Performance Cryogenic Sapphire Oscillators

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Three nominally identical microwave cryocooled sapphire oscillators (CSO) have been implemented at the University of Adelaide. The sapphire resonators have a turning point in their frequency-temperature dependence at approximately 6 K, which delivers first-order insensitivity to temperature fluctuations when operated at this point. Combined with a loaded Q-factor of 10^9, similar oscillators have shown fractional frequency stabilities of $\sigma_y = 5.8*10^{-16}$ at 1 s [1]. In order to understand the current limits to the performance of these oscillators, a detailed investigation of the noise contributions has been untaken. This effort has included the construction of a mathematical model of propagation of self-noise through the control systems used. We will detail the theory and workings of the CSO, and provide a brief analysis of the limiting noise sources. Finally, we will present the performance of the oscillators and a breakdown of each aspect of the noise into its limiting source.

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Experimental exploration of an interacting 2D Fermi Gas

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Fermi gases cooled to ultracold temperatures allow unique insight into the behaviour of particles at the quantum level. Tuning of parameters associated with interaction and confinement can also lead to the creation of exotic phases of matter. More precisely, 2D Fermi gases will allow studies of the crossover from a Bardeen-Cooper-Schrieffer to Berezinskii-Kosterlitz-Thouless type superfluidity. Production of the 2D Fermi gas is achieved by application of a cylindrically focussed blue-detuned TEM01 mode laser which confines lithium-6 atoms to 2D by making the vibrational states of the harmonic potential in the transverse direction energetically inaccessible compared to the radial. Here I present data on our recent experiments exploring the criterion for 2D in a Fermi system as well as our current results for the equation of state of a 2D Fermi gas.

A bright source of spectrally pure photons at telecom

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Photons have long proved the preferred architecture for tests of quantum information science. Owing to their ease of manipulation, long coherence times and robustness to noise, photons are ideal for carrying information over long distances. However, virtually all photon-based quantum protocols have been limited by low detector efficiencies, line losses and photon source inadequacies. One of the key challenges for quantum technologies is to produce single photons, and pairs of entangled photons, more efficiently. Here we demonstrate a bright, high-heralding efficiency source through careful engineering of the pump-beam and crystal parameters, coupled with superconducting nanowire single photon detectors (SNSPDs) with detection efficiencies of up to 90%. The collinear type II SPDC source consists of a periodically-poled Potassium Titanyl Phosphate (pp-KTP) crystal, pumped at $785nm$ with down-conversion in the telecom range. The quasi-phase matching of the crystal is engineered to satisfy both the group velocity matching and phase matching conditions at the telecom wavelength, producing photons of high-spectral purity and eliminating the need for harsh spectral filtering. Initial data shows a preliminary heralding efficiency of 52%. This should be compared with typical pulsed down-conversion experiments, which demonstrate heralding efficiencies of up to 25%. The source is further characterised through construction of the joint spectrum, and measurements of the Hong-Ou-Mandel interference and the $g^{(2)}$. With highly efficient photon sources at the telecom wavelength range, coupled with fast and efficient detection, we can realise long distance quantum information experiments, such as unconditional EPR-steering over long distances.

Using two frequency combs with quasi-integer-ratio repetition rates for high-resolution spectroscopy

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Frequency combs are broadband laser sources whose spectra are composed of a large amount of narrow modes with precisely known positions. They thus have a great potential for spectroscopic applications. When using a pair of combs with almost identical repetition rates, it is possible to probe and sample the impulse response of an optical device to recover its spectrum. Here, we demonstrate a generalized method for dual-comb spectroscopy that involves the use of two frequency combs with quasi-integer-ratio repetition rates. A 16.67 MHz comb is used to periodically probe a long ring cavity containing fine spectral features while a 100 MHz comb asynchronously samples its impulse response. The resulting signal can be thought of as six time-multiplexed independent interferograms that can be averaged later on. The data is afterward demultiplexed and corrected with referencing signals. We obtain a measurement of the cavity's spectrum with 16.67 MHz of resolution and a SNR of 55 dB by averaging 15,000 interferograms, corresponding to a measurement time of 500 s. Compared to conventional dual-comb spectroscopy which uses almost identical repetition rates, this generalized technique allows to either gain spectral resolution or sampling speed by changing the repetition rate of only one of the combs.

Trench-assisted large mode area fiber for high power fiber lasers

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High power fiber lasers have tremendously contributed to mankind for high power fiber laser applications. Now fiber lasers are being as seen as the potential candidates for next-generation particle accelerators, nuclear transmutation, nuclear waste treatment, astrophysics, and other industrial applications. Unfortunately, non-linear effects are detrimental to the power scaling and pose severe challenges for further power scaling. One route to increase output power level is to increase the effective area of the fundamental mode. However, increasing the core diameter to increase the effective area of the fundamental mode leads to propagation of several modes and deteriorates the output beam quality. Hence, a trade-off exists between large effective area and beam quality for power scaling. Several large mode area fiber designs have been proposed to achieve effective single-mode operation by offering suppression to the higher order modes. However, these fiber designs are difficult to fabricate and suffers from several other problems.

We have proposed a novel all-solid "trench assisted" fiber designs, which are easy to fabricate and offer significant enhancement to mode area scaling capability. Fiber having core diameter as large as 90μm has been experimentally demonstrated to guide single mode operation. We believe that these designs offer potential to address the challenges being faced by high power fiber lasers.

Tailoring the efficiency of stimulated Brillouin scattering on a chip using photonic bandgap structures

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On-chip nonlinear optics is a thriving field of research presenting vast opportunities for classical and quantum signal manipulation in small foot-print integrated devices. Since optical nonlinearities are weak, nonlinear interactions are commonly enhanced by exploiting high-Q resonances or using materials with large nonlinearities. This, however, often results in amplification of several competing nonlinear processes simultaneously, which limits power efficiency and can cause signal distortions. Here, we exploit the frequency dependency of the optical density of states near the edge of a photonic-bandgap structure to selectively enhance and inhibit nonlinear interactions on a chalcogenide chip. We demonstrate this concept for one of the strongest nonlinear effects, stimulated Brillouin scattering (SBS). The SBS enhancement enabled the generation of a 15-line Brillouin frequency comb. In the inhibition case a two-fold increase for the SBS threshold was achieved.

Ultrafast Laser Spectroscopy of Conjugated Polymers

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Conjugated polymers are organic semiconductor materials that possess interesting optical and electronic properties and thus have applications in organic optoelectronic and photovoltaic devices. Interest in conjugated polymers is mainly due to their function as light harvesting and electron donor materials in plastic solar cells. For this reason, ultrafast laser spectroscopy is an ideal technique to study these polymers.

This presentation will outline several types of time-resolved spectroscopic experiments, such as multi-pulse transient absorption, fluorescence lifetime and fluorescence anisotropy measurements. While the target will be conjugated polymer films and solutions, the concepts and techniques can be applicable to photoactive materials in general where charge generation and energy transport are of interest.

Ionisation of metastable neon using ultrafast laser pulses

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The study of interactions between ultrafast light pulses and matter is currently very topical. This paper presents recent results taken by performing ionisation of metastable neon (Ne*) using 6.3fs laser pulses. This is, to the best of our knowledge, the first time such as experiment has been undertaken with this particular atomic species, and as such it is our aim to establish both the laboratory equipment and analysis techniques. Ne* is generated using a DC discharge source before interacting with the light pulses in the detection device, a Cold Target Recoil Imaging Spectroscopy (COLTRIMS) device. The COLTRIMS records time of flight, ion and electron momentum spectroscopy data. Ion yield data will be presented from pulses in the 10^{13}-10^{14}W/cm^2 regime.

Ultrafast Mid-IR fiber lasers- shortest pulses at the longest wavelengths

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Pulsed fiber lasers venturing to longer wavelengths (approximately 3 μm and beyond) promise to be compact and efficient sources for mid-infrared photonics. As a specific example, minimally invasive laser surgery can be achieved by using picosecond pulses with a wavelength near 2.9 μm, which reduces the damage area of surgical incisions by orders of magnitude. However, achieving laser radiation at these mid-infrared wavelengths has been difficult due to the lack of suitable optical components. In this talk we present the demonstration of a range of passively mode-locked fiber lasers operating at 2.86 μm which produced 6-30 ps pulses, the shortest pulses produced at these wavelengths, with evidence to demonstrate its stability. The main challenge however has been measuring these ultrafast pulses accurately. To date, most characteristics of pulses have had to be indirectly inferred or estimated. To overcome this we have developed a Frequency Resolved Optical Gating (FROG) apparatus to operate at the mid-infrared to measure the complete characteristics of these pulses. Our findings indicate that pulse widths are not limited by dispersive effects of the cavity, contrary to previous results, but rather the properties of the saturable absorber. This allows for a clearer understanding of the mode-locking dynamics and lays the foundation for future mid-infrared fiber laser designs to move into the femtosecond regime.

Experimental semi-device-independent certification of entangled measurements

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Certifying the entanglement of quantum states with Bell inequalities allows one to guarantee the security of quantum information protocols independently of imperfections in the measuring devices. Here we present a similar procedure for witnessing entangled measurements, which play a central role in many quantum information tasks. Our procedure is termed semi-device-independent, as it uses uncharacterized quantum preparations of fixed Hilbert space dimension. Using a photonic setup, we experimentally certify an entangled measurement using measurement statistics only. We also apply our techniques to certify unentangled but nevertheless inherently quantum measurements.

Rf-induced association of ultracold molecules in ^{87}Rb.

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In 2010 two theoretical papers [1], [2] proposed radiofrequency-induced Feshbach resonances at arbitrary magnetic fields. In such process two scattering atoms are coupled by a high power rf field to a bound molecular state inducing the Feshbach resonance. Our team reports the first observation of rf-induced resonances for a mixture of two states $|F = 1,\ m_F$=-1$\rangle$ and $|F = 2,\ m_F$=+1$\rangle$ in ^{87}Rb. We observe a sudden increase of atom losses in narrow ranges of rf-frequencies that clearly indicates the molecule association. We measured the energies of five different bound states of diatomic molecules Rb_2 in magnetic field range from 0.15 to 3.3 Gauss. During data analysis we worked out an explanation for observed asymmetries of resonant curves that significantly decreased uncertainties in resonant frequencies localization. Interpolating our data down to zero-magnetic field we can calculate zero-field energies of ultracold molecules with a few kHz precision. New method of radiofrequency molecule association can be employed to any other mixtures of atoms and used for creation and studying new molecules.

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The Effect of Ti Adhesion Layers on the plasmonic properties of Gold Nanorod Arrays.

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Fabrication of gold nanorod arrays using electron beam lithography (EBL) technique has attracted increasing interest due to its diverse applications in the field of multidimensional optical data storage, optical nano-antenna design and nano-scale optics. Gold nanorods are especially appealing due to their tuneable strong surface plasmon resonance (SPR) absorption in the visible to near-infrared (NIR) region. However, it requires precise control to fabricate these nanostructures to maintain subnanometric accuracy as these SPR characteristics are highly sensitive to the variations of the shape and size of the nanorods. Along with this, the addition of adhesion layer between gold and substrate also cause significant changes in its plasmonic properties.

In this paper, we systematically investigate the SPR mediated scattering properties of electron beam lithographically fabricated gold nanorods arrays by exploring different thickness of Titanium(Ti) as an adhesive layer. We also measure the damped plasmon phase using different thickness of Ti as a probe. We fabricated arrays of gold nanorods sizes (around 97nmX37nm) much smaller than the excitation wavelength by gradually varying the thickness of Ti and observed distinct features in scattering for different thicknesses of Ti.

Optical characters of self-assembled graphene oxide film

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Since the discovery of graphene in 2004, this rising star has emerged rapidly both on the horizon of materials science and modern physics. Graphene oxide (GO) and reduced graphene oxide (rGO), prepared by chemical oxidation of graphite and subsequent exfoliation in water and reproduction, have been regarded as graphene alternatives for easy preparation and cost-effective production. Self-assembled graphene oxide (SAGO) film benefits from its homogeneous property, which is a promising GO product in many fields. Due to its unique optical and electronic properties, the application of SAGO and reduced SAGO (rSAGO) in solar cells, flexible electronic devices, sensors, batteries and supercapacitors can make a giant enhancement in the performance. However, the study of SAGO and rSAGO are mostly limited to the mechanical and electrical properties, few investigations have been reported on the optical properties, which limits the applications in optics.

In this study, high quality SAGO thin films are prepared and photo-reduced by using UV and femtosecond laser. The optical property of SAGO and rSAGO thin films are studied by using a broad band ellipsometer covering the wavelength range from UV to infrared. The physical fitting model for SAGO and rSAGO is discussed to find the best fitting values of the refractive index and extinction coefficient.

Ion Fluorescence Collection And Diffraction Limited Imaging From A Microfabricated Ion Trap With Integrated Diffractive Mirrors

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Progress towards large scale trapped-ion quantum information and communication requires trapping architectures to be miniaturized and made scalable with little or no increase to trapping complexity. We describe the use of microfabricated diffractive mirrors for compact and scalable optical interconnects. The high collection efficiency of diffractive mirrors will also speed up ion-photon and remote ion-ion entanglement rates.

Diffractive mirrors are planar mirrors which impart position-dependent phase shits equal to that of a bulk mirror. Our diffractive mirrors use a stepped approximation to the ideal phase shift profile which give us a theoretical diffraction efficiency of 50% and a solid angle coverage of 13%. An array of 9 diffractive mirrors was designed, containing 3 test optics and 5 that collimate the collected ion fluorescence perpendicular to the trap surface. Our diffractive optics were fabricated at the Fraunhofer HHI and integrated with a microfabricated trap, supplied by GTRI (Georgia Tech. Research Institute).

Our experiments are all conducted using $^{174}\mathrm{Yb}^{+}$ ions, which fluoresce at the mirror design wavelength of 370 nm. We have seen 4±1% fluorescence collection efficiency from our collimating diffractive mirrors, similar to the standard efficiency of bulk collection optics. Re-imaging the collimated fluorescence onto a CCD camera we have seen a FWHM of 346±22nm which is near our setups diffraction limit of 292nm.

3.5 µm tuneable Er:ZBLAN fibre laser

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The development of mid-infrared (3-5 µm) fibre lasers has seen tremendous development in recent year driven by their applications in defense, environmental monitoring and medical applications. To push fibre laser to operate on ever longer wavelengths with higher power levels, various approaches have been taken including supercontinuum generation[1], Raman based fibre lasers [2] and rare-earth doped lasers [3]. Rare earth doped fibre lasers have strong potential for increased power levels with good beam quality and easy thermal management.

We have recently demonstrated mid-infrared lasing centred at 3.5µm and reaching 3.6 µm [3]. In this work, we used a dual wavelength pumping technique to demonstrate efficient fiber laser operation on the $^4F_{9/2}$ to $^4I_{9/2}$ transition in Er^{3+}:ZBLAN glass fiber. Over 260 mW of average output power was obtained at room temperature. Maximum optical-to-optical efficiency achieved accounting for both incident pumps was 15.9%.

Our most recent work will be presented . These results include an increased power scaling of the 3.5 µm fibre laser approaching 400 mW at 3.5 µm. In addition, the first demonstration of wavelength tuning spanning 200nm on the $^4F_{9/2}$ to $^4I_{9/2}$transition will be discussed.

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Radiation Dosimetry using Fluoride Phosphate Optical Fibres

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Radiation dosimetry using optical fibres is a method which has attracted attention, due to the potential to make probes, remote sensing and distributed sensing devices for ionising radiation. In this study, fluoride phosphate (FP) glasses have been used to fabricate optical fibres capable of sensing ionising radiation using the mechanism of optically stimulated luminescence (OSL). This method is unique in that no external materials are spliced onto the fibre to produce a signal, the fibre itself is capable of producing an OSL response.

The ionising radiation sensing properties of FP glass has been studied and experimental work performed to optimise the OSL response of the glass. The addition of Tb^{3+} to the FP glass by doping with Tb_4O_7 under an ambient melting atmosphere was found to improve the OSL intensity from 9.3×10^5 counts/g to 8.6×10^7 counts/g.

This glass was then fabricated into optical fibres and tested using beta irradiation from a $^{90}Sr/^{90}Yr$ beta source and X-ray irradiation from an X-ray tube. The OSL response of fibres was then characterised, important parameters studied were reproducibility of the OSL signal, the dependence of the signal on absorbed dose, and the capability of the fibres for distributed sensing.

Optical fibres were found to work efficiently as OSL dosimeter devices, with a dependence between dose and OSL intensity. Reproducibility of results was established, however the effect of photodarkening on the fibre transmission loss was found to effect results after exposure to high dosages.

Design and Study of Nano-plasmonic Couplers Using Aluminum Arsenide and Alumina

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A theoretical study of nano-plasmonic couplers constructed using aluminum arsenide (AlAs) and alumina (Al_2O_3) is presented. The analysis has been done using the finite difference time domain (FDTD) technique. The dependence of coupling efficiency on the width of the air layer of silver-air-silver waveguide has been investigated in order to determine the optimal width of air. Coupling efficiency with the variation of input signal wavelength, reflection coefficient, return loss and insertion loss have been calculated numerically in order to characterize the performance of AlAs and Al_2O_3 as nano-plasmonic couplers. The resonant peaks have also been obtained for both AlAs and Al_2O_3. The couplers provide appreciable performance at 1550nm wavelength and have simple rectangular shape with no tapering which provides advantage in the fabrication process. It also offers broadband operation.

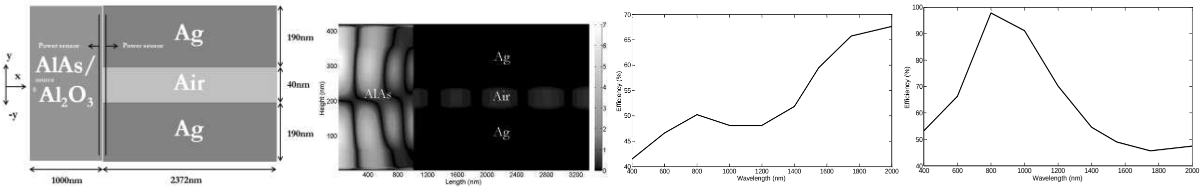

Figure: (i) Proposed structure (ii) Electric field distribution inside the structure (iii) Efficiency vs wavelength for AlAs (iv) E vs W for Alumina

Phase Sensitive Amplification in Silicon Waveguides: Experiment and Theory

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Phase sensitive amplification (PSA) is an attractive function due to its potential for noiseless amplifiers and phase regenerators in telecommunications, and for generation of squeezed states of light in quantum processing. Silicon is a compelling material for integrated PSA due to its high nonlinearity and compatibility with CMOS processing. In our previous work we demonstrated 11 dB extinction ratio PSA in a record short 196 μm silicon photonic crystal on-chip waveguide. A drawback of silicon is two-photon absorption (TPA) that significantly restricts the desirable Kerr effect through attenuation of the optical intensity and generation of free carriers. Despite the presence of TPA and free carriers effects in silicon material, which restrict the maximum phase sensitive gain, we found that the extinction ratio is not significantly degraded. Therefore, detailed understanding of the limitations of TPA and free carriers on PSA and pulse-propagation is highly desired. The existing analytic descriptions of PSA consider the lossless or linear loss cases, while the solutions for pulse propagation in silicon only describe pulse evolution either without free carriers or with small free carrier effects. In this work, we provide an analytic approach for four-wave mixing-based silicon PSA in the highly nonlinear limit, including the effects of linear loss, TPA and free carriers. The analytic method gives a clear insight into how TPA and free carriers modify the pulse evolution and the PSA gain. This method is confirmed by experimental results and numerical modelling. With our method, we can predict the PSA gain under both pulsed and continuous wave pumping conditions. The results provide general guidelines for designing on-chip PSA in the presence of TPA and free carriers.

Rubidium Spectroscopy with Exposed Core Fibre

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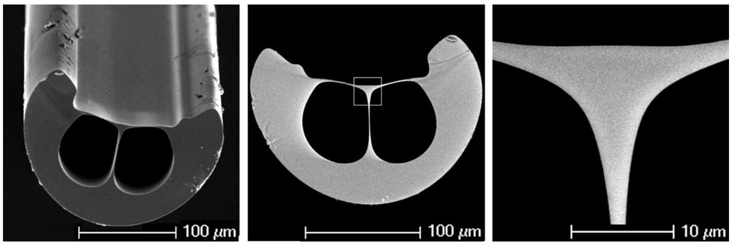
The development of exposed-core micro-structured optical fibre (pictured below) is a promising platform for ultra-strong light-atom interactions, and therefore efficient light-light interactions. Such interactions are desired in the field of quantum optics where photon-photon interactions are required for a universal set of quantum logic gates. Exposed-core fibre could enable this through the intense evanescent field created along the exposed side of the fibre's core.

Our project aimed to demonstrate interaction of the guided modes of the exposed-core fibre with a surrounding Rubidium vapour. We have observed excitation of the $5S_{1/2} \rightarrow 5D_{5/2}$ two-photon transition of Rubidium using counter-propagating 780nm and 776nm laser beams confined to the core of an exposed-core fibre. Excitation of this two-photon transition demonstrates the fibre's potential to generate photon-photon interactions, and it's potential for use in quantum logic applications.



SEM image of the exposed-core fibre geometry, with an enlarged view of the core (right).

Vortex Gyroscope Imaging of Bose-Einstein Condensates

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Turbulence is a regime of flow characterised by chaotic behaviour with a rapid variation of local properties in space and time. Currently turbulence is modelled by empirical relationships inferred from experimental data, accurate within only a small regime of flow properties. An analytic understanding of turbulence would vastly improve our understanding of these phenomena and allow cheap and accurate computational modelling to replace experimental testing.

The behaviour of turbulence is greatly simplified in quantum mechanical systems. In a quasi-2D Bose-Einstein condensate (BEC), turbulence is manifested via the dynamics of parallel vortex cores. A good understanding of the system can be obtained if the position and sign of each vortex is known. With modern experimental techniques, vortex locations are routinely measured by optical means, however a general procedure for determining each vortex sign has remained elusive.

We numerically simulate a robust experimental method, with the possibility to distinguish vortices from antivortices in BEC's. Tilting the planar condensate prior to standard absorption imaging excites the gyroscopic mode of each vortex to reveal both the sign and location.

If successful in the laboratory, this method will give us direct insight into the behaviour of quantum turbulence in superfluids and advance progress towards obtaining an analytical understanding of turbulence.

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Photoacoustic imaging system for monitoring molecular diffusion in scattering tissue-like phantoms and in vitro samples

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Photoacoustic Tomography (PAT) has been extensively applied in the past decade for a variety of practical applications. Various modalities of the technique enable imaging at different depths with a wide range of spatial resolutions. In this report, for the first time we present a PAT system which is capable of imaging molecular diffusion processes in scattering tissue-like phantoms and in vitro tissue samples. The system is built to observe the diffusion process of various solutions (e.g. Indian ink) as well as optical clearing agents. In this talk the emphases will be given to the technical aspects related to the system construction and imaging techniques. The results of experiments demonstrating good potential of utilizing PAT to monitor diffusion in purpose of measuring and analysing skin condition or transdermal drug delivery will be presented.

Strong optical activity in all dielectric 8-srs nets

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Three-dimensional laser nano-fabrication technology allows for the fabrication of custom chiral nanostructures, such as photonic crystals that exhibit optical activity or circular dichroism with potential for optical devices.

The 8-srs gyroid network is one such network that exhibits a strong chiral-optical response. For parts of the frequency spectrum, a dielectric 8-srs is transparent to both right- and left-circularly polarised light yet exhibits optical activity comparable to metallic metamaterials [1].

We demonstrate the successful fabrication of the first dielectric 8-srs network and experimentally characterise its chiral optical properties, obtaining a good match with numerical simulations.

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Magnetization with ultrasmall lateral size and ultralong longitudinal depth realized by the inverse Faraday effect

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Magnetization with ultrasmall lateral size and ultralong longitudinal depth has potential applications in ultrahigh density magnetic data storage and fabrications of magnetic nanostructures. In this presentation, firstly, an optical coherent method to realize magnetization with an ultrasmall lateral size is proposed theoretically. By carefully controlling the incident light field, magnetization with opposite orientations can be induced in the central and peripheral regions respectively in the focal plane through the inverse Faraday effect and the lateral size of the magnetization in the central region can be smaller than 30 nm in one dimension; Secondly, an ultralong optical needle with pure transverse polarization is numerically generated by tightly focusing an azimuthally polarized beam through an annular vortex binary filter. We show that such a pure transverse optical needle can induce pure longitudinal magnetization with a subwavelength lateral size (0.38λ) and an ultralong longitudinal depth (7.48λ) through the inverse Faraday effect. The corresponding needle aspect ratio of 20 is twice as large as that of the longitudinal magnetization needle generated by electron beam lithography.

Improved method for simulating whispering gallery mode spectra of active spherical microresonators

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The whispering gallery modes (WGMs) of microresonators represent an important tool for biosensing, due to their sensitivity and extremely high Q-factors. By modelling the behaviour of the WGMs computationally, one can tailor the refractive-index and geometry of a resonator, and predict the spectral profile in any chosen window of wavelength. This can elucidate previously unexplored regimes of the resonator, and dramatically reduces fabrication costs by preselecting the desired optical properties/resonance peak positions.

Here, for the first time, we investigate the excitation of the WGMs of a polystyrene microsphere, by a point-source electric dipole, oriented tangentially to the sphere's surface. The use of a dipole source provides an analogue for embedded nanoparticles, potentially exhibiting different mode excitation properties. Using an FDTD simulation we calculate the output power spectrum, which is collected by a circular flux plane for a range of wavelengths (530-670nm), and analyse the mode structure of the spectrum. This represents the first step in providing a new customisable WGM assessment tool for use in prefabrication procedures.

Ultrafast Laser Source for Fast Trapped Ion Quantum Logic

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Trapped ions are one of the promising candidates for the successful implementation of quantum information processing. The best result achieved so far for quantum logic gate times is about 10 μs with trapped ions, which is still a big hurdle yet to overcome. We construct a laser system which has capability to address this problem, and has been discussed succinctly. It is a multistep process which begins with harmonically mode-locked Er-doped fibre (EDF) laser as a fundamental oscillator. The oscillator produces femtosecond pulses at 1564 nm wavelength with a repetition rate of 300 MHz. This light is amplified and compressed to produce supercontinuum using highly non-linear fibre (HNLF). We slice the spectrum and select 1110 nm of wavelength by using fibre Bragg gratings (FBGs) for high power amplification to 3.5 W and up-conversion to 370 nm. We have produced 175 mW of 370 nm light with pulse duration ~ 2 ps and 300 MHz repetition rate. Switching technique has been developed to execute geometric phase gates with time durations of ~ 100 ns.

J.J. Garcia-Ripoll et al., Phys. Rev. Lett. **91**, 157901 (2003)
M. J. Petrasiunas, M. I. Hussain et al., Opt. Express, **22**, 17716 (2014)

A New Type of Fluoride Fiber Laser at 2.8 µm

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We report the demonstration of an Er-doped fluoride fiber laser operating at 2.8 µm. This laser uses a special fiber Bragg grating in an architecture which is classical for traditional wavelength ranges but which was previously impossible to make in Er-doped fluoride glass. A first prototype was built in-house and showed laser emission. Using a second identical laser, a heterodyne beat experiment was conducted to measure a specific property which proves that the laser is operating as intended. A characterization of the output power was also made and showed that pump noise has a negative impact on the performances of the laser. With a few improvements, this laser could open new horizons for mid-IR optical metrology.

Optical magnetic superresolution imaging of biological samples enabled by NV centres in nanodiamonds

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The non-toxicity and bio-compatibility of nitrogen vacancy (NV) centres in nanodiamonds make them unique fluorescent candidates for in-vivo imaging of biological samples. In particular, the optically detected magnetic resonance (ODMR) signal of single NV centres allows super-resolved optical imaging combined with magnetic sensing application [1]. The implementation of nanodiamonds in life science strongly relies on the emission properties of the NV centres. When the size of nanodiamonds is reduced via oxidation process to below 70 nm, fluorescence intermittence or blinking occurs. Blinking NV centres have enabled the development of super-resolved optical imaging methods with an accuracy of 20 nm [2]. In this paper ODMR of blinking nanodiamonds will be presented. The beam at the wavelength of 532 nm with linear polarization is employed as the excitation source. The blinking fluorescent signal is collected and the microwave stimulation enables the detection of the ODMR signal. The ODMR signals in blinking nanodiamonds have laid new ground for the development of nanoscale biomarkers for both super-resolution optical imaging and magnetic sensing. The nanoscale magnetic sensing will be developed by measuring the ODMR signal of nanodiamonds in biological samples.

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Propagation of Laguerre-Gaussian laser beams in turbid tissue-like scattering medium

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Presently due to high sensitivity of the angular momentum of light to subtle alterations in medium morphology there is a growing interest to the Laguerre-Gaussian (LG) laser beams, known also as twisted photons. We present the results of Monte Carlo-based computational studies of different LG beams propagation through turbid tissue-like scattering media. The results obtained for LG beams are presented in comparison with the results for Gaussian beams propagating in the scattering media of same optical properties. Classic physical phenomena, such as a preserving of orbital angular momentum, its flip, and effect of optical memory are observed for the LG laser beams of different orbital angular momenta. The computational model is developed in house and accelerated by parallel programming on graphics cards.

Array of subwavelength apertures on dielectric media for beam deflection at optical frequencies

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Recent advances in nanotechnology allow antenna miniaturization to the nanoscale where optical waves can be manipulated in unprecedented ways. This work will focus on arrays of subwavelength apertures with high transmission and beam control. A set of transmitarrays that operate at optical frequencies are designed and simulated for beam deflection. These structures are created on a silicon substrate with pyramidal-shaped holes of varying depth which constitute a sequence of phase shifts across the interface of the dielectric. This approach to phase discontinuities is superior to existing nanoantenna designs as dielectric apertures exhibits low loss as compared to metallic resonators. When the designed transmitarray is illuminated with a normally incident beam, the transmitted beam is deflected by a predetermined angle. This design concept of beam control can pave the way for more complicated discretized lens design for various applications.

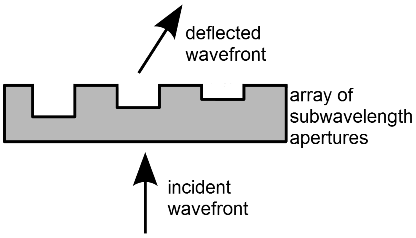

Figure 1: Graphical representation of the array of subwavelength apertures designed for beam deflection

Testing Fundamental Atomic Physics with He*

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The workhorse of atomic physics: non-relativistic quantum electrodynamics is one of the best-tested theories in physics, consistently producing results that are stunningly accurate (exceeding one part in 10^{11} agreement for helium energy levels). However there are difficulties producing predictions and measurements of parameters such as the transition dipole matrix elements beyond the fraction of a percent level of accuracy.

In order to develop the theory further we aim to measure the transition dipole matrix elements of metastable helium (the ideal 3 body test-bed) to the highest accuracy thus far. To do so we have employed a “tune-out wavelength” which occurs when the dynamic polarizability of all atomic transitions sum to zero; thus illuminating an atom with this wavelength then produces no net energy shift. This provides a strict constraint on the transition dipole matrix elements without the complication and inaccuracy of branching ratios and light field intensity measurements traditionally employed.

We report on progress towards measuring the 413.02nm tune out wavelength from the metastable 2^3S_1 state to just below the 389nm 3^3P_J triplet of helium which is expected to be sensitive to finite mass, relativistic and QED effects. It is the accurate determination of the 413.02 nm tune-out wavelength that we aim to use to challenge non-relativistic quantum electrodynamics predictions.

Ultrafast Simulations for Ultracold Gases

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As the popularity of using hybrid magnetic and optical dipole traps for generating Bose Einstein Condensates grows, the need for highly efficient cooling schemes in these trap configurations becomes paramount. To optimise such complex systems it is necessary to fully understand the intricate physics encountered at each stage of the cooling process. To this end we have developed a Direct Simulation Monte Carlo (DSMC) simulation based on the CUDA architecture to study the dynamics of non-adiabatic spin transitions (aka Majorana spin flips), which are the source of inefficient atom losses during the transition from magnetic to optical dipole trapping.

We will present here the results of recent simulations which use a Monte Carlo Wavefunction method to simulate the internal quantum state responsible for the Majorna spin flips. We have successfully been able to simulate a spin flip for a trapped atom in a representative one-dimensional trap, and hope to present the results of integrating this method into our existing DSMC simulations for an ultracold atomic gas.

Femtosecond Laser Processing for High Efficiency Large Scale Thin-film Amorphous Silicon Solar Cells

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The growth of the photovoltaic (PV) industry has been dramatic in the recent years. Thin film amorphous Silicon solar cells are a promising technology for photovoltaic applications due to their lower material cost compared to crystalline silicon. Typical thin-film solar cells consist of back contact, absorber and front contact films deposited on inexpensive substrates. In thin-film amorphous Silicon solar cell current is produced by the movement of carriers, electrons and holes, to the back and front contact layers, respectively. The photocurrent is decreased by scribing the module into a large number of mini-modules and connecting them in series to create a high-voltage, low-current device. The scribing is performed in 3 steps - P1 denotes scribing of the front contact layer for defining each individual cell and P2/P3 denote selective removal of the absorber layer and back contact layers. We intend to use femtosecond laser scribing technolgoy to process the thin-film amorphous Silicon solar cell which would obtain the higher efficiency compared to nanosecond laser scribing used widely in industry so far. The material removal by ultrashort laser processing, in which the bonds holding the target material together are directly broke and essentially the material is then atomized, is called cold photoablation. This is a relatively cold process which could achieve narrower scribes leading to less heat-affected zone (HAZ). In the meanwhile, it is very clean, leaving no recast material, with minimal need for post-processing. The efficientcy of thin-film amorphous solar cell is increased by the improvement of these parameters.

Cavity-resolved high-resolution frequency comb spectroscopy

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An optical frequency comb is a nearly ideal light source for absorption measurements, as it allows simultaneous interrogation of a target species at hundreds of thousands of equally spaced frequencies. An ideal system would utilise every comb mode independently, however this is difficult to achieve in practice due to the relatively close spacing of comb modes (in our case 250 MHz).

A low finesse optical filter cavity placed prior to interrogation of a molecular sample suitably decimates comb modes for implementation in an imaging system consisting of a virtually-imaged phased array (VIPA), diffraction grating and near-IR camera. This successfully overcomes issues resolving individual comb modes when utilising the optical frequency comb as an interrogation source in conjunction with a VIPA etalon.

Initial work has focused on the construction and demonstration of the optical filter cavity in its effectiveness in decimating the comb output for spectral analysis, culminating in the acquisition of HCN spectra.

This project has the potential to achieve a frequency axis accurate to the kilohertz level and 250 MHz resolution for molecular absorption spectra, covering a large spectral band very quickly. Such a device would be invaluable tool in a range of contexts wherein fast, accurate, quantitative spectral analysis is desirable.

Linear optical quantum C-SWAP gate

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To build quantum gates one may consider a variety of quantum systems: ions, atoms, superconducting charges, photons, etc. Linear optical quantum information takes advantage of single photons which provide low-noise, scalable and versatile physical systems. Most quantum information tasks require strong non-linear interactions between photons- this is highly non-trivial to induce directly. A widely used alternative is the KLM scheme, where such a non-linearity can be achieved probabilistically using only linear optics, auxiliary single photons and projective measurements. However the resource overhead for KLM accumulates rapidly when extending beyond two qubits. Hence we must explore new schemes to accomplish this more efficiently. Here we use one such scheme to experimentally realise the first linear optical controlled-SWAP gate, also known as the Fredkin gate. Its logic primitive consists of three inputs: a control and two target qubits, which swap at the output conditional on the state of the control qubit. We use two Type-II spontaneous parametric down-conversion sources to generate two pairs of entangled photons. Two of the photons serve as target qubits, one as the control and the remaining as a trigger. The target photons are mixed on a polarising beam splitter such that the Hilbert space of our three qubit, polarisation entangled, state is expanded to the spatial modes of each photon. This allows the SWAP operation to be applied to one path only. Measurements are performed in four-fold coincidences, to preserve state fidelities. We demonstrate a gate fidelity of 97% in the logical basis. Our scheme requires only entangled photons, linear optics and an ‘expanded Hilbert space’ technique which significantly simplifies the implementation of the control element in our gate.

Sneaky spin spy: a continuous probe for spinor condensates

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Spinor condensates are ultracold matter clouds with a spin degree of freedom presenting a highly tunable system for quantum simulation. A wide variety of interesting features such as solitons and spin waves can be imprinted, but observing them typically involves destructively splitting the cloud into its spin components, letting it ballistically expand, and measuring resonant absorption. We present a complimentary technique that provides continuous in-situ measurement of the condensate spin over long timescales ($\sim$ 500ms) using the off-resonant Faraday effect. We demonstrate applying this technique to observe spin dynamics and extract cloud profiles, then discuss using techniques from magnetic resonant imaging (MRI) to spy on the dynamics of features smaller than the diffraction limit.

Integrated generation of photon pairs with all-optically reconfigurable quantum states

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Spontaneous parametric down-conversion in nonlinear waveguide arrays (WGA) provides an interesting platfrom for the generation and quantum walks of entangled photon pairs. We utilize special domain poling patterns in the WGA to shape the output quantum state, and we also show that the state can be reconfigured in real time by varying the calssical laser driving of the array.

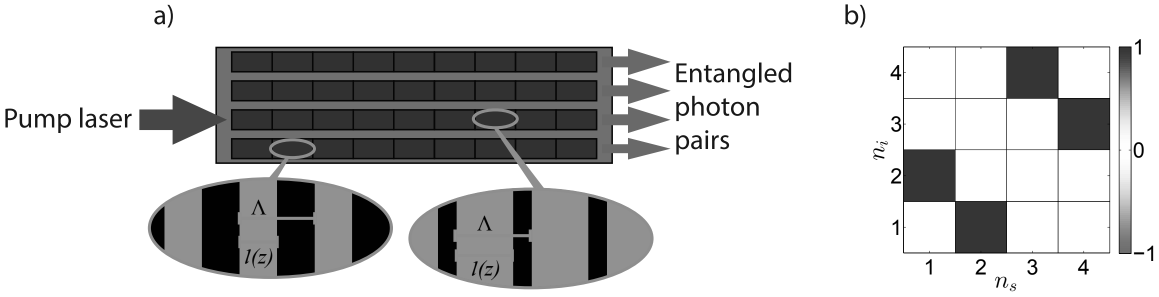

Figure 1: a) Diagram of a waveguide array with special $\chi^{(2)}$ poling. b) Example output wavefunction of entangled photon pairs produced by downconversion of pump laser in the WGA.

Detecting supercooled water and ice crystals in cloud

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Water droplets inside a cloud is supercooled when temperature goes below freezing level, but maintain liquid state, so that mix phase clouds exist when there are both ice crystals and supercooled droplets. The cloud phase and its microphysics (ice crystal shape, size and density etc.) can affect radiative balance of the atmosphere. One study indicates the radiative forcing of cirrus with moderate optical thickness may vary over 100W/m2.

In order to understand the cloud phase and its morphology, in-situ measurement is more precise than ground based or satellite base measurement. The balloon borne polarization backscatter sonde (polarsonde) is constructed to measure cloud phase, based on different depolarization ratio of the backscattered signal between droplets and ice. We also make another balloon launched instrument: Ice Crystal Imager (ICI) designed to image ice crystals and large water droplets. The polarsonde and the ICI has been tested in the ice cloud chamber in the University of Manchester. The experiment shows the ICI is able to image ice crystals with different habits, like column, plate, sector plate and their aggregates, also the polarsonde results shows a depolarization difference of 0.1 between water droplets and column ice crystals.

Study of High Optical Power Effects in Gravitational-Wave Detectors

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Abstract: Gravitational waves, which were predicted by Einstein's General Relativity, have not been directly detected yet. The assembling of the advanced gravitational-wave detectors are going to be completed in 2015, which commit a sensitivity of 10 events per year. The design of the advanced detectors includes a circulating laser power up to 800 kW inside the arm cavities of the interferometers. My research is focused on multi-mode optomechanical interactions and one of the effects that such high optical power would result in, namely, parametric instability. Parametric instability was observed in our 74-meter cavity and an approach of suppressing it is demonstrated. In addition, an automatic alignment system is introduced to compensate the slow drifting of the optical path and the suspended cavity due to the seismic vibration.

Sub-wavelength Imaging Using Three-dimensional Negative Refraction in 3D Photonic Crystals in Optical Regime

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Negative refraction means that the phase velocity of a propagating wave, which describes the propagation of individual wave fronts in a wave group, is opposite to the movement of the energy flux of the wave, represented by the Poynting vector. This property can recover the decaying components of refracted light, therefore makes a perfect lens. Flat two dimensional (2D) photonic crystal (PC) lenses with negative refraction are able to focus light along just one direction thus have limitations for realistic applications. High order of symmetry in 3D PCs make it possible to control light in different directions, in which way light can be focused in three dimensional to overcome diffraction limit for high resolution. Although 3D negative refraction has been achieved with cubic structure working at microwave frequency [1], focusing light in optical regime from all directions in 3D PCs has not been explored yet. Optimizing PC structures is possible to overcome the fabrication barriers in optical regime, based on all angle negative refraction [2] and anomalistic index distribution, for instance PC with gradient index. Our work aims at achieving sub-wavelength imaging in optical frequency with dispersion control and PC structure optimization.

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2. C. Luo, S. G. Johnson, and J. D. Joannopoulos, Applied Physics Letters **81**, 2352-2354 (2002).

Photoreduction of graphene oxide towards photonic applications

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The photoreduction of graphene oxide (GO) has recently attracted a great deal of attention due to the tunable physical properties of reduced graphene oxide (rGO) by manipulating its oxygen content. In particular, the conductivity, nonlinearity, absorption and refractive index of rGO have been demonstrated to be highly dependent on its photoreduction extent, which can be effectively manipulated by the photoreduction strategies. Moreover, the controllable patterning capabilities of arbitrary structures on GO film can be achieved simultaneously during its photoreduction process. Notably, a resolution of 300 nm in the micropatterns has been realized by using femtosecond laser direct writing (LDW)-induced photoreduction of GO. In this paper, I will review our recent progresses on the investigation of photoreduction of graphene oxide. First of all, the tunable optical properties of rGO have been studied extensively. Then the LDW of GO has been optimized for higher resolution patterning. Finally unique photonic devices have been designed and realized on GO films. In conclusion, the photoreduction of GO provides a unique material platform with controllable physical properties as well as flexible patterning capabilities, which may pave the way for novel photonic applications.

Ultrasonically Assisted Deposition of Colloidal Crystals

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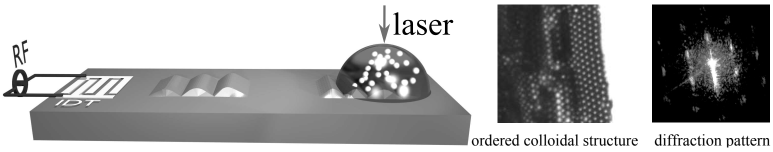
Colloidal particles are a versatile physical system which have found uses across a range of applications in optics such as photonic crystals, and optical switches and filters. Utilization of colloidal particles often requires a means to produce highly ordered, periodic structures. One approach is the use of surface acoustic waves (SAWs) which allow a high compactness of the setup and extended control of directing the self-assembly of colloidal particles compared to other methods. Previous demonstrations using standing SAWs were shown to be limited in terms of crystal size and dimensionality. By using traveling SAWs, we can demonstrate a large improvement in spatial alignment (Wollmann et al., APL, 031113 105, 2014). Optical characterization techniques allow us to measure the enhanced quality and dimensionality of the crystal growth controlled by the radio frequency power which drives the SAW. We show that this technique can be applied to a range of particle sizes in the μm-regime and may hold potential for particles in the sub-μm-regime.



ordered colloidal structure diffraction pattern

Quantum State Smoothing

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We introduce *quantum state smoothing*, a quantum estimation model where the state of a partially observed open quantum system itself is smoothed. We achieve this by applying classical smoothing to a hypothetical unobserved noisy measurement record correlated with the stochastic dynamics ("*quantum trajectories*") of the system, induced by that hypothetical measurement. In the *quantum trajectories formalism*, the quantum-conditioned state is directly related with classical stochastic results, in the form of currents or photo detections, which can be directly smoothed with the well-developed classical smoothing theory. Having a smoothed version of these classical variables would smooth indirectly the quantum state of the open system of interest. Using this formalism, we simulate quantum state smoothing for a simple system, and study how the choice of unravelling for the true observation of the system affects how well the unobserved results can be estimated, and hence how effective is the quantum state smoothing. Our investigations shed new light on the nature of open quantum systems and the applicability of classical concepts.

Optical Bioassays: Integrating Nanogold with Immunoassays

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Fiber optic biosensors have been used extensively due to its simplicity, ease of multiplexing, integration with various sensing phenomena and high sensitivity. There is a need to develop point of care, in expensive, user friendly diagnostic device for screening of diseases like Diabetes, Tuberculosis, Alzheimer's, heart diseases, etc. Various immunoassays have been used to detect some of these diseases but they use fluorescent tags for quantifying the test. These fluorescent tags have problems like photobleaching, incompatibility with some biomolecules and stability issues. Nanoparticle research has provided a potential solution to the above problem. In this work, we have combined fiber optic sensors, immunoassays and gold nanoparticles to develop an optical immunoassay. We have explored two configurations: first having gold tags on evanescent wave absorption platform and other combining localised surface plasmon resonance and gold tags. Both platforms showed atleast 20 times enhancement in sensitivity of an on-fiber immunoassay configuration compared to conventional fluorescent tags based immunoassays.

Towards Photonic Topological States

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Weyl points are three-dimensional linear point degeneracies between two bands, analogous to the lower dimensional Dirac point that can exist in two dimensional dispersion relations. Unlike the Dirac point, Weyl points are predicted to be stable in momentum space with topologically non-trivial associated surface states.

High refractive index photonic crystals, based on a double-gyroid structure with space group ,
are predicted to exhibit frequency-isolated Weyl points with complete phase diagrams by breaking the parity and time-reversal symmetries [1].

Here, we show progress towards the fabrication and characterization of parity symmetry broken high refractive-index double-gyroid structures that are expected to possess the frequency isolated linear point degeneracies in their three dimensional dispersion that define the illusive Weyl point.

[1] **L. Lu**, et al., Weyl points and line nodes in gyroid photonic crystals, **Nat. Phot. (7)**, 2013

What is PDH and how can it stabilise your PhD?

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Many applications in the field of optics require lasers to have a well-defined wavelength, a narrow linewidth, or often both at the same time. Some of these applications include gravitational wave detection, optical spectroscopy, optical frequency standards and optical metrology. A common technique for improving an existing laser's linewidth and stability is known as Pound-Drever-Hall (PDH) stabilisation. Using this method, a laser can be locked to a stable wavelength reference, such as an ensemble of atoms or a Fabry-Perot cavity.

Stabilised lasers offer an accurate method of measuring trace gases, as they can be locked to the target's absorption wavelength. The detection of methane is an increasingly important issue, particularly regarding possible leaks in pipelines and gas/oil-drilling activities. Considering that methane possesses a global warming potential (GWP) 25 times that of carbon dioxide over a 100-year period it is highly desirable to develop a broadly applicable system that can quickly and accurately locate methane emissions over a large area.

A common technique for long-range measurements is LIDAR, where laser pulses are used to probe targets at range. In a LIDAR system designed for the detection of trace gases, the PDH technique can be used with a methane reference to lock the laser to the target molecule. This presentation will explore the theory behind PDH stabilisation, as well as its practical application in the development of a long-range methane detector.

Launching Surface Plasmons with Dielectric Resonator Antennas

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Low-loss dielectric resonator antennas (DRAs) have been demonstrated at optical frequencies as highly efficient nano-antennas. This work focuses on designing a nonuniform array of cylindrical nano-scale DRAs made of TiO_2 on a silver surface to couple and launch surface plasmon polaritons (SPPs) unidirectionally. When excited by a normal incident planewave, a cylindrical DRA can operate in its fundamental resonant mode, which is equivalent to a horizontal magnetic dipole on the metal plane. The field distribution of this horizontal magnetic dipole resembling that of SPP implicates high coupling efficiency. Moreover, DRAs with different sizes can provide different phase responses to the incident waves. By varying the radius of a DRA, a 2π variation of phase can be achieved. Therefore, with proper arrangement of DRAs of different sizes in a nonuniform array, constructive interference can be achieved towards one side of the array while destructive interference can be achieved in the opposite direction. Thus, a unidirectional SPP launcher can be built. Simulations of the DRA-based launchers for operation at 633 nm wavelength show good coupling and launching performance and now the work is moving towards fabrication and experimental verification. These SPP couplers are a promising candidate for applications in integrated optics.

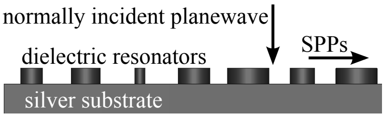

Figure 1: Graphical representation of the nonuniform array of DRAs for SPP unidirectional launching

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Frequency up-conversion of microwave photons into optical photons via Raman processes in an Er:YSO crystal

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In the later years a lot of advances have been done in the field of quantum communications, but many obstacles are yet to be surmounted. In particular, a lot of progress have been made in the development of superconducting qubit based devices, which couple naturally to microwave photons. These devices, however, present a series of limitations, including the inability to send quantum states over long distances or the lack of a suitable long term quantum memory. A possible solution for this, and the one we explore, is to coherently convert these microwave photons into optical photons, for which the aforementioned problems are easier to solve.

In this work we present a novel approach towards conversion of microwave photons into optical photons at telecommunication wavelengths. We perform a Raman heterodyne spectroscopy experiment based on an erbium doped crystal inside a microwave resonator at cryogenic temperatures. We show that frequency conversion is achieved, and present a solution to increase the efficiency of the process.

A Novel Power play in the supercontinuum spectra of saturable nonlinear media

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We investigate the role of pump power in the generation of supercontinua spectra induced by modulational instability in the saturable nonlinear media (SNL). We identify and discuss the salient features of SNL. Firstly, we analyze the dynamics of modulational instability (MI) in the SNL using linear stability analysis. Following the detailed MI analysis, the subsequent section deals the generation of broadband spectrum by virtue of instability process. We identified the unique behavior of MI in the SNL system. Unlike the case of Kerr type nonlinearity, the so called critical modulational frequency (CMF) does not monotonously increases, rather behaves in a unique way, such that the increase in power increases the CMF up to the saturation power, and further increase in power decreases the CMF. This behavior is identified to be unusual in the context of MI and thus makes the study of MI or the supercontinuum generation (SCG) quite interesting. In order to confirm the above stated behavior in the SCG perspective, numerically we analyzed the SCG using split-step Fourier method and the results confirm that at input power equal to saturation power the phase matching occurs at relatively short distance than for other power level and leads to the maximum enhancement of SCG in certain SNL materials. We believe that our reported theoretical results will set a benchmark for new experiments aiming to probe the various nonlinear effects in the SNL system.

Heat and polarization driven effects for permanent opto-magnetic recording in a low concentration rare Earth element TbFeCo alloy

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Abstract: We have achieved a permanent switch in $Tb_{14}Fe_{68}Co_{18}$ alloy by excitation with circularly polarized single pulses with left and right helicities. Two windows of helicity dependent and completely absorption dominated switching were distinguished. Other two windows for instantaneous ultrafast helicity driven heat assisted effects, followed by pure thermal spin dynamics were found.

6.3 W Ho^{3+}, Pr^{3+} Co-Doped Fluoride Fibre Laser

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Mid-infrared photonics has attracted growing interest in recent years owing to the strong resonance of light in this region with many characteristic molecular vibrational transitions. Of particular interest is the infrared region surrounding 3 μm, corresponding to a prominent water absorption peak and an atmospheric transmission window. ZrF_4-BaF_2-LaF_3-AlF_3-NaF (ZBLAN) based fiber lasers operating on the $^4I_{11/2} \rightarrow {}^4I_{13/2}$ transition of erbium ion are the most heavily researched in this region, currently delivering tens of Watt power levels at 2.8 μm. Alternatively, holmium based systems allow for lasing of the $^5I_6 \rightarrow {}^5I_7$ transition at 2.9 μm. Such systems remain particularly viable candidates for high powered operation as they offer a comparatively higher Stokes efficiency limit of 40.5 % (when pumped at 1150 nm) coupled with reduced pump excited state absorption. However, demonstrations of high powered emission have been limited by available pump power.

In this work, increased output power from a holmium system is achieved through the development of a power scalable 1150 nm pump system. A diode-pumped Ytterbium fibre laser was used as a pump source for an efficient Raman fibre laser in order to shift the wavelength to 1150 nm, this was used as the pump system for a Ho^{3+}, Pr^{3+} co-doped fluoride fibre laser. A maximum output power of 6.3 W was generated, with a slope efficiency of 28 %.

Information Erasure in Small Systems

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For small systems there are fluctuations in an erasure process which violate Landauer’s bound. Dillenschneider and Lutz [1] found the probability at which this will occur

$$\Pr(W < \beta^{-1}\ln(2) - \varepsilon) \leq \exp(-\beta\varepsilon) \qquad (1)$$

where β is the inverse temperature and W is work. Vaccaro and Barnett have shown that erasing information can be achieved using another conserved quantity. This means *no energy cost* is needed to erase information [2]. We investigated Eq.(1) in terms of the erasure of information for a small system of energy-degenerate spin-1/2 particles, with the conserved quantity being angular momentum J_z. Our results, lend further support to the general principles that *the erasure of information is associated with a cost, but that cost is not necessarily in terms of energy* and that *the same kind of statistical uncertainty is associated with erasure of information irrespective of the nature of the cost.*

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Cirrus and Mixed Phase Clouds over Adelaide

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Cirrus and mixed phase clouds represent a major uncertainty in climate modelling. Climate models need a better understanding of cirrus and mixed phase clouds' radiative properties and lifecycle. Important properties include height, frequency of occurrence and thermodynamic phase. These properties can be measured with polarimetric lidar. An existing lidar instrument was upgraded to a polarimetric lidar. The lidar has been run for 6 month; 3 months with polarisation measurements. We have measured the above mentioned properties up to heights of around 6 km, including ice at heights of 1 to 2 km in frontal clouds. Our measurements agree with ground and satellite based lidar, and with radiosonde measurements. Methods for determining addition properties of the clouds, such as the Lidar Ratio were researched. Sufficient measurements of cloud macrophysical properties would allow for determination of cloud microphysical properties, such as particle density and shape. To assist with determining these properties a polarimetric lidar simulation was written. However, sufficient properties were not measured due to the instrument lacking sufficient range and resolution. Higher range and resolution can be achieved by using a higher power laser.

Detector dependency of diffusive quantum monitorings

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Measurements play a pivotal role in the study of dynamical open quantum systems. Dyne detections are among the most widespread and common measurement schemes of this sort which all can be explained in the framework of quantum diffusion equations. In this work we study detector dependency of the conditional state of a system subject to continuous diffusive measurements of an arbitrary number of environments to which the system is coupled. We prove that this problem can be formulated in the context of semi-definite programming that are solvable with adequate precision and competence. Different physical systems with diverse measurement settings are also scrutinized to reveal ample information about the strength of quantum diffusion on ruling out objective evolution of the system state.

Measurements on the reality of the wavefunction

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Since the beginning of quantum theory, one of the most debated foundational issues has been the precise status of the quantum wavefunction. Despite being a key mathematical object in describing quantum mechanical systems, it is unclear whether it represents reality or simply the knowledge of reality. A fundamental property of quantum mechanics is that non-orthogonal states cannot be perfectly distinguished. If the quantum wavefunction did represent reality, then two non-orthogonal states would be physically distinct. Thus it is puzzling that this distinctness cannot be readily detected. However, taking an epistemic view in which the quantum wavefunction represents a classical probability distribution over underlying states of reality, then non-orthogonal states simply correspond to overlapping probability distributions. Using a high precision single photon experiment, we demonstrate that no knowledge interpretation can fully explain the inability to distinguish non-orthogonal quantum states.

Quantum Mechanical States for Atoms in Disordered Optical Lattices

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The many-body ground states for systems of atoms at zero temperature in two dimensional disordered optical lattices are investigated theoretically. The ground states are found using the Bose-Hubbard model [1], approximating the system state with the Gutzwiller Ansatz (see Figure), and their characteristics are then investigated. The superfluid and condensate fractions are evaluated in order to identify the transition into a Bose glass as the randomness of the lattice is increased [2]. The density distribution and density-density correlations are calculated for a Bose glass state which has been allowed to expand freely in space. Both the density distribution and the density-density correlation are found to closely resemble those of the Mott insulator, an insulating state found in a homogeneous lattice.

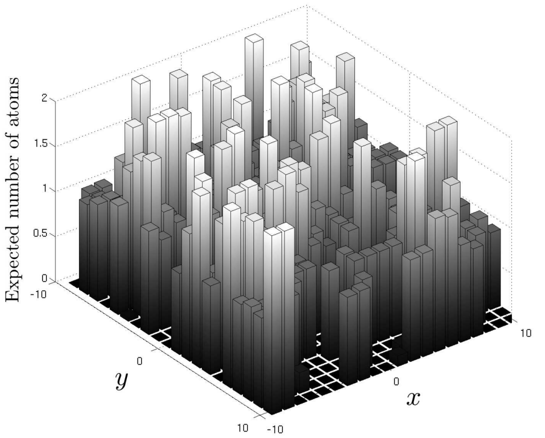

Figure: Expected number of atoms at each lattice site in the presence of random laser speckle.

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Nonlinear magnon dispersion in a ferromagnetic spinor Bose-Einstein condensate

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We have computationally studied the propagation of spin waves in spinor Bose-Einstein condensates in the context of the recent experiment [Marti et al., 2014], which measured an unusually heavy magnon mass in a ferromagnetic ^{87}Rb spin-1 condensate and attributed the observation to beyond mean-field effects. Our mean-field simulations indicate that the magnon dispersion frequency in these systems is strongly dependent on the polar tip angle θ of the generated spin wave excitations. In the limit of $\theta \to 0$, we find the effective magnon mass to be equal to the bare atomic mass, in accordance with Bogoliubov-de Gennes theory. These observations are further corroborated by a complementary method for measuring the magnon mass based on dispersing Gaussian magnon wavepackets.

Application of Dielectric Gratings for Absorption Enhancement in Photovoltaics

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The development of clean, renewable energy sources is a necessary step in the mitigation of anthropogenic climate change and the fulfillment of a growing global energy demand. Solar cells are likely to play a pivotal role in achieving this goal, particularly within Australia. In this project we investigate how a dielectric grating positioned on top of an absorber can enhance the absorption. Through computer simulations using the CUDOS developed, open-source simulation package, EMUstack, we explored the underlying physics of gratings and how they can contribute to absorption enhancement. By implementing an electric field visualization subroutine for homogeneous films, we could achieve an intuitive understanding of the electric field profiles within the structure. Through the application of this feature, in conjunction with other features of EMUstack, we observed that the grating lead to a rich variety of resonances. Understanding a single grating, we explored multiple gratings with the intention of exciting highly evanescent fields within the absorber. We demonstrated that the presence of one or more dielectric gratings results in significant absorption enhancement over the high irradiance region of the solar spectrum, with peak absorption values as high as 99.7%.

Vortex Dynamics in Two-Dimensional Bose-Einstein Condensates

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We study computationally the dynamics of quantised vortices in two-dimensional Bose-Einstein condensates using the Gross-Pitaevskii and point-vortex models. The latter, which aims to simplify the dynamics of the vortices by treating them as point particles, has been calibrated to yield matching results with the Gross-Pitaevskii model. We have applied both of these models to a turbulent two-dimensional superfluid, in which an initially random configuration of many vortices is evolved in time. During the turbulent dynamics, vortex-antivortex annihilation events cause the number of vortices in the condensate to decay, driving the system towards large scale Onsager vortex clusters. Our two-dimensional Gross-Pitaevskii simulations indicate that such vortex clustering is possible in a uniform trap; however, it appears that this clustering is suppressed in the case of harmonic trapping. We are developing point-vortex models with phenomenological vortex-antivortex annihilation to study the effects of sound waves, trapping geometry and dimensionality on the formation of Onsager vortices.

Measuring the Mass Composition of Ultra High Energy Cosmic Rays

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Cosmic Rays (CRs) are extra-terrestrial particles possessing energies of up to 10^{20} eV of unknown origin. When a CR enters the atmosphere, it interacts with molecules in the air and initiates a giant cascade of secondary particles known as an Extensive Air Shower (EAS). These particles can emit fluorescence light as they move through the air by excting atmospheric nitrogen molecules.

The Pierre Auger Observatory, located in Argentina, is the largest CR detector in the world, covering an area over 3000 km^2. It consists of approximately 1600 water-Cherenkov detectors overlooked by 29 fluorescence telescopes comprising of five separate sites, which operate in a 'hybrid' mode to reconstruct information about a CR from a detected EAS. By using the fluorescence telescopes to find the atmospheric depth where the amount of fluorescence light emitted from an EAS is at a maximum, information regarding the mass composition of the CR can be determined. This can provide key insights into understanding things like when CRs transition from galactic to extra-galactic in origin.

Compact Q-Switched Er:YAG Lasers at 1.64μm

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Er:YAG lasers at 1.64mm are required for a variety of remote sensing applications, including "eye-safe" coherent LIDAR, ranging and the detection of methane. To obtain short duration, high energy pulses, a compact resonator with a high round trip gain is required. I have built a compact Er:YAG slab laser that is resonantly pumped using a fast-axis collimated 1.47μm laser diode. The Co-Planar Folded zigzag slab (CPFS) maximises the gain length product for a given slab size, without excessively increasing the length over which the pump must be absorbed.

My laser was initially tested in gain-switched mode, operating with a 40% reflective output coupler, previously unheard of in Er:YAG lasers. Q-switching was achieved by the combination of a Pockels cell and Quarter Wave Plate; the best observed result was a 6mJ pulse of ~15ns duration.

Further work will involve adapting this laser for cavity dumping, which may achieve even higher peak powers by shortening pulse duration to <5ns.

Integrated Homodyne Detection at Telecom Wavelength

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Lithium Niobate waveguide technology allows for the integration of many quantum optics processes onto a chip sized area. Using this technology a table of optics can fit into the palm of your hand. Optical homodyne detection is the preferred method of quantum state characterisation in many cases due to the potential for complete reconstruction of the density matrix via quantum state tomography. Most homodyne detectors are limited by photodiode efficiency and imperfect mode overlap. By integrating the homodyne detector into lithium niobate waveguide technology, and customising our electronics to allow implementation of 98% efficient photodiodes, we create a homodyne detector, integrated on chip with low detection losses at 1550nm.

Degenerate Correlated Photon Pair Generation in an Ultra-compact Silicon Chip

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Correlated photon pair generation via spontaneous four-wave mixing (SFWM) in a nonlinear photonic chip is a promising approach to provide scalable single photon sources for quantum photonic technologies. In most previous demonstrations, two correlated photons were generated at different colour and therefore were not indistinguishable. For such a photon source to be useful, two sources are required to perform quantum interference. This involves a four-fold coincidence measurement, which is much more challenging than two photon coincidence measurement.

Here, we present indistinguishable photon pair generation via slow-light enhanced degenerate SFWM in a 96 μm long silicon photonic crystal waveguide for the first time. This represents 50 times smaller footprint than the recent report using silicon nanowires. The source demonstrated here will be directly plugged into future quantum photonic experiments to increase the degree of integration.

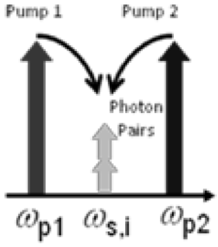

Figure. Two Pump photons are annihilated to generate an indistinguishable photon -pair.

Room temperature and cryogenic operation of an Er:YAG laser using a cooled InGaAsP diode

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Laser diodes are an inexpensive way of pumping high-power solid state lasers with broad absorption bands. In Er:YAG, a series of peaks in the 1450-1490 nm region are typically used for diode pumping. To pump a narrower absorption peak efficiently, either the spectrum of the diode must be narrowed using expensive and complex grating components on each emitter, or a different pump source must be used. We investigate improving the properties of standard InGaAsP diodes by cooling them below 0°C, in order to produce an efficient cryogenic Er:YAG laser.

Characterisation of a cooled InGaAsP diode has already been completed, along with lasing results for a room temperature Er:YAG slab. The cooled InGaAsP diode has higher efficiency, lower threshold, and smaller beam divergence than the same diode operated at room temperature. Spectroscopic studies indicate that the cooled InGaAsP pump will be superior to a room temperature InGaAsP pump for the cryogenic Er:YAG slab due to greater pump absorption combined with the higher efficiency of the diode, with laser results forthcoming.

Atoms in an external magnetic field

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We investigated the production of a highly stable external magnetic field which can be used to tune the interactions between ultracold atoms in an optical dipole trap. For this pursuit, part of the coil configuration of the existing magnetic trap was implemented. Using dispersive probing and adiabatic rapid passage the stability of the coils in the setup were analyzed. Furthermore first results from the ultracold atom laboratory at Otago on the observation of Feshbach resonance are reported.

High resolution measurement of two photon spectral correlations in the quantum and classical regime

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The development of reliable photon sources is essential for the development of quantum photonic technologies. It is important to be able to characterize and engineer the entanglement between photons, whether this arises naturally or introduced via the manipulation of the photon pairs. Spectral photon correlation measurements are often used to quantify the degree of time-energy entanglement present; however this typically requires long acquisition times and limited in resolution. Recently, a new method of charactering some types of entanglement, stimulated emission tomography (SET), was proposed and implemented for measuring the joint spectral characteristic of photons from spontaneous parametric down-conversion [3]. In this paper I will discuss methods of characterizing the joint spectral intensity of third-order nonlinear photon pair sources. The first is a high resolution quantum characterization of photons generated via spontaneous four-wave mixing (FWM) using a automated filter [4]. The second is a purely classical method of SET measurement using stimulated FWM.

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Measuring the mass of a vortex in a superfluid

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We present an experimental proposal to measure the mass of a vortex in a Bose–Einstein condensate (BEC). Quantised vortices are one of the hallmarks of superfluidity and superconductivity. These topological defects have been observed in a variety of systems including liquid helium, BECs and superconducting currents. The dynamics of vortices is important for describing many physical phenomena and applications in which turbulence is involved, from the dynamics of neutron stars or the decay of superconducting currents through to the aeronautical engineering.

If the quantised vortices of a superfluid are thought of as quasi-particles, then their dynamics should be determined by Newton's second law, $\mathbf{F} = m_{dyn}\mathbf{a}$, where m_{dyn} is the dynamic mass of the particle. There has been much debate in the literature on the value of the mass of a vortex, ranging from negligible to infinite. Recently, Thouless and Anglin (PRL **99**, 105301 (2007)) showed that by pinning a vortex to a repulsive potential, the mass is sensitive to the form of the pinning.

We plan to measure the mass of a vortex in a ^{87}Rb condensate by using ^{41}K atoms as pinning potentials. A species selective dipole potential can be used to hold the ^{41}K atoms and drag them relative to the condensate. We can then use the technique propoesd by Thouless and Anglin to measure the mass by observing the motion of a vortex as its pinning potential is driven in a circle. By using a Feshbach resonance we can tune the strength of the interaction between the ^{87}Rb condensate and the ^{41}K pinning potential. By altering the pinning strength and the number of ^{41}K atoms used, we can observe the dependence of the mass on the form of the pinning.

Exposed Core Microstructured Optical Fiber Surface Plasmon Resonance Biosensor

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Surface Plasmon Resonance (SPR) scattering offers significant advantages compared to traditional reflectivity measurements, essentially turning a non-radiative process into a radiative one. Recently, we have shown that SPR scattering can be used in an optical fiber, enabling higher signal to noise ratio, reduced dependence on the metallic thickness as well as the unique capability of multiplexed detection with a single fiber. We propose a novel SPR scattering based sensor fabricated based on an exposed-core silica Microstructured Optical Fiber (MOF). This MOF presents a structure with a relatively small core ($\O = 10\mu m$), exposed along the whole fiber length. This exposed core MOF allows for fabrication of SPR supporting metallic thin films directly onto the fiber core offering the new prospect of exploiting SPR in a waveguide structure that supports only a relatively small number of guided optical modes, with a structure that offers ease of fabrication and handling. While sensitivity of the exposed core fiber based SPR sensor is comparable to a large bare core fiber SPR platform, we demonstrate that usage of the exposed core fiber results in an increase of the Q factor of SPR peaks yielding potential improvement of the detection limit for this SPR biosensing architecture.

Passive Mode-locking of a Thulium-doped Silica Fibre Laser

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Passive mode-locking of thulium-doped (Tm-doped) silica fibre lasers at ∼2 μm have many benefits in medicine and machining. We report work on passive mode-locking of a Tm-doped silica fibre laser with the use of a semiconductor saturable absorber (SESA) and a semiconductor saturable absorber mirror (SESAM). A 790 nm diode pumped passive Q-switched Tm-doped silica fibre laser using an intracavity SESA operating at ∼1.95 μm is presented. Also, a 790 nm diode pumped passive Q-switched mode-locked Tm-doped silica fibre laser using a SESAM operating at ∼1.95 μm is presented. The Q-switched pulses exhibit a period of 4.04 μs and a repetition rate of 248 kHz, peak power of 0.97 W, pulse energy of 0.81 μJ and pulse duration of 835 ns. The Q-switched mode-locked pulses exhibit periodic mode-locked pulses of period ∼8 ns.

Whispering gallery mode biosensing - optimal sensor design

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Whispering gallery modes (WGM) have been extensively studied, both theoretically and experimentally, for applications in biosensing due to their ability to conduct highly selective, sensitive and label-free detection of molecules. The majority of the work previously conducted however, has focused on using only a handful of resonator materials. Silica and polystyrene are most commonly utilized with other materials remaining largely untouched. Investigating other resonator materials provides an opportunity to extend the WGM platform and may assist in creating specialized biosensing devices. Key characteristics such as the quality factor and sensitivity of the resonator, along with considerations of the final application contribute to the final determination of the optimal WGM sensor design. This work looks to predict and investigate the combinations of resonator material and size, along with excitation and coupling scheme to provide guidelines to assist in the decision making when undertaking refractive index biosensing with WGM in a range of situations.

Octave spanning mid-IR supercontinuum generation in a silicon-on-sapphire waveguide

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Silicon photonics has recently received significant interest with demonstrations ranging from fundamental studies of soliton physics to high-level applications like signal processing for the next generation of telecommunications. One appealing application that has received particular interest is on-chip sensing of molecules using broadband light in the mid-Infrared (2-5 μm). In the mid-IR, many important molecules have fundamental ro-vibrational absorption lines and thus probing with mid-IR light allows for sensitive detection (ppb, ppt) of these molecules. Silicon waveguides are a potentially ideal platform for this application due to its wide transparency in the mid-IR. The key aspect is to have an on chip broadband mid -IR source which can be achieved by exploiting optical nonlinear processes of silicon to generate supercontinuum. In this work, we present a >1000 nm extension of the longest reported supercontinuum wavelength in a silicon nanowire by using sapphire as the substrate, which is transparent to >5 μm. The spectrum generated represents the widest supercontinuum reported using silicon photonics. This supercontinuum is limited on the short wave side by linear scattering losses and on the long wave side by multi-phonon absorption in the sapphire substrate.

Tying knots in matter

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Within the last 20 years it has been demonstrated both theoretically and experimentally that knotted nodal structures may exist within optical fields. The existence and realization of these structures has shown a unique demonstration of creativity and the precision of control of optical manipulation, as a knotted nodal structure completely determines certain characteristics of the optical field. We have extended this work to the domain of Bose-Einstein Condensates (BEC's) where a BEC of Rubidum-87 atoms was imprinted with a complex scalar field structure, and in the low density limit, evolves into the desired knotted nodal structure as has been previously demonstrated within optical fields. This work is a first demonstration of vortex structures within BEC's that realize complex topologies, and clearly shows the precise control we now have over the wave nature of matter.

Electrical Energy Storage Integrated Solar Cells Using Laser Reduced Graphene Oxide

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Abstract: Carbon based energy storage is the most promising candidate for integration with the solar cells. Cost effective way for the fabrication of these devices is direct laser writing, which does not involve any complicated processing technology.

Solar cells are one of the most promising renewable energy technologies available in the current market but the intermittent nature of solar energy becomes a major obstacle in considering it as primary energy carrier. The most effective way to meet this crisis is to have an improved and integrated energy storage system with the solar cells. Carbon based energy storage especially reduced graphene oxide comes to the priority list for the integration due to its high surface area and conductivity. Also they are non-toxic in nature. We propose the use of femtosecond laser for the reduction of graphene oxide in desired patterns for large uniform area using the multifocal fabrication method. The low repetition rate of femtosecond laser pulses with high NA objectives results in high electrical conductivity and closer electrodes. This will give rise to high electrical energy storage. Due to the ease of fabrication, these can be directly prepared on solar cells without the requirement of an additional medium.

High Bandwidth Laser Polarisation Spectroscopy

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Stable, high bandwidth, narrow linewidth lasers are critical to quantum atomic physics experiments. They are used in metrology, atomic clocks, atomic trapping and cooling and high resolution spectroscopy. External cavity diode lasers (ECDL), which are generally used in this field, have a linewidth of 100's of kHz when frequency stabilised using saturated absorption spectroscopy.

Polarisation spectroscopy, an alternative to saturated absorption spectroscopy, uses a circularly polarised pump beam to create birefringence in a sample of gaseous atoms around the atomic resonances which are then probed with a linearly polarised beam[1]. The polarisation of the probe beam is rotated by the birefringence induced by the pump which can be observed with a balanced polarimeter and is idea for laser locking[2].

Recently it was shown that using polarisation spectroscopy the linewidth of a distributed feedback laser, known for its stability and large linewidth, was reduced from 2 MHz to 20kHz[3].

Using polarisation spectroscopy it is possible to generate error signals with bandwidths around 40 MHz which in turn allows ECDL's to be stabilised to a linewidth of 12.5kHz.

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[3] Torii, Y., Tashiro, H., Ohtsubo, N. & Aoki, T.,Phys. Rev. A86,033805 (2012)

Carbon Nanotube Functionalised Exposed Core Fibre

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Carbon nanotubes (CNT) have been successfully deposited onto an exposed core optical fibre for the first time. Exposed core optical fibres with small cores provide access to large overlap of the guided mode with the CNT coating. A coated fibre system such as this offers enhancement of nonlinear effects within optical fibres and has applications within the field of all optical signal processing and communications.

Here we present recent progress made in dispersing single walled carbon nanotubes in an organic medium, which is then used to coat an exposed core optical fibre. In addition, developments towards characterising and optimising the CNT coating and measurements of the fibres optical properties will be presented.

Self-pulsing and excited-state absorption in Tm:YAlO$_3$

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Tm:YAlO$_3$ (or Tm:YAP) lasers operating at 2 μm are excellent laser sources. However, the tendency for Tm:YAlO$_3$ lasers to self-pulse, even under continuous-wave pumping, limit their usefulness. Razdobreev and Shestakov [1] showed that the pulsing could be explained by including phonon-assisted excited-state absorption (ESA) at the lasing wavelength in the rate equations. However their model required a significant ESA cross-section. They also pointed out that the measurement of the ESA cross-section has not yet been performed and was necessary to verify the model.

We describe the experiment used to measure the cross-section of the ESA at the laser wavelength. The measured cross-section is an order of magnitude lower than that required by the published model. We also reproduce the published model and show that the lower value does not reproduce the self-pulsing behaviour, and hence the model is insufficient to describe the self-pulsing in Tm:YAlO$_3$. An alternative theory is necessary, such as Lorenz-type chaos.

[1] I. Razdobreev and A. Shestakov, Phys. Rev. A **73**, 53815 (2006).

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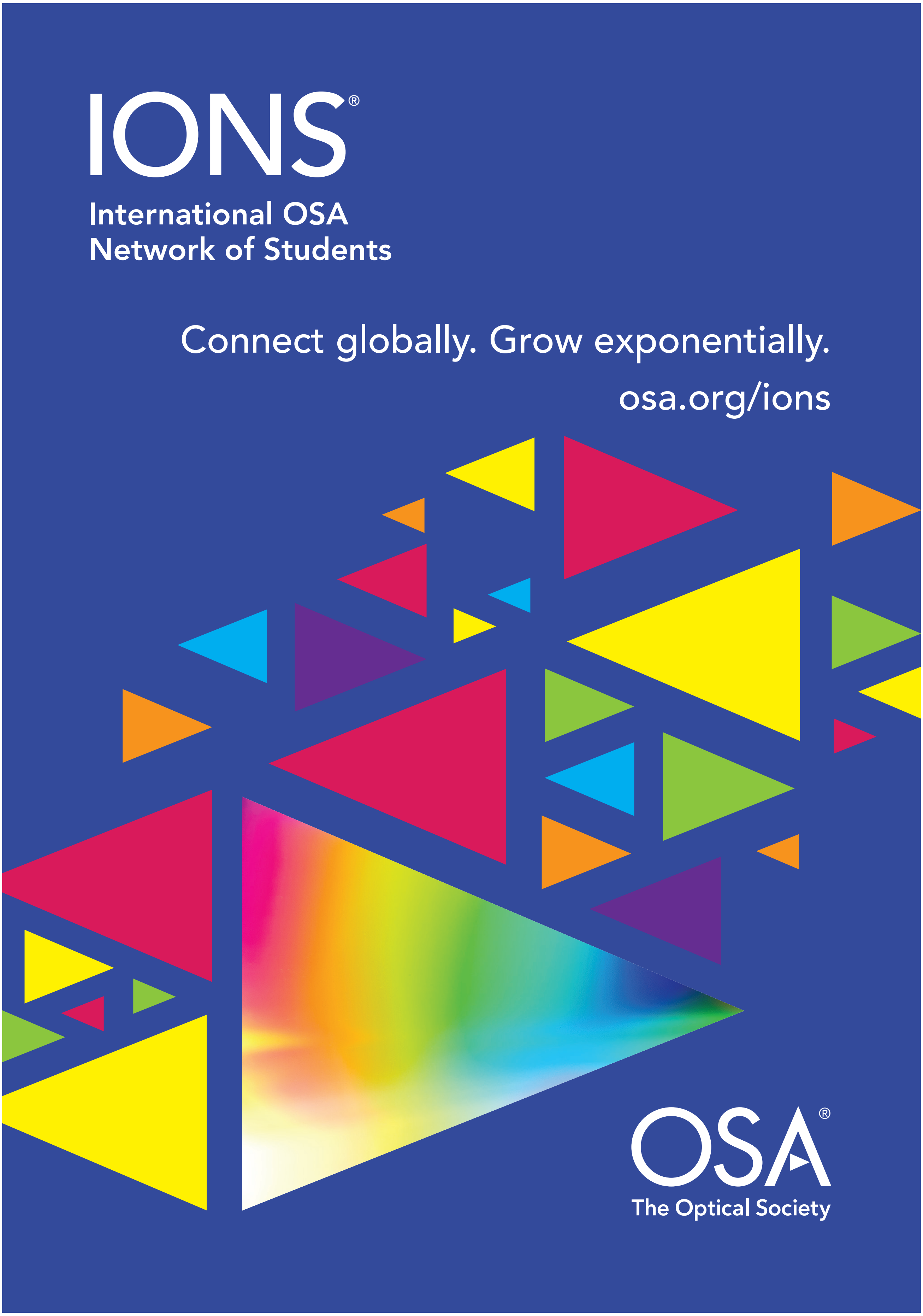

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Centre for Nanoscale BioPhotonics

The ARC Centre of Excellence in Nanoscale BioPhotonics (CNBP) is a transdisciplinary research centre with a focus on delivering high quality research outcomes whilst empowering a new generation of researchers; inspiring the community with the wonders of science; and seeding new industries with our disruptive technologies. Our scientific aim is to extend the boundaries of knowledge in nanoscale photonics and in the science of surfaces to drive new approaches to sensing at the nanoscale that will power new ways of understanding cellular processes within the human body. This truly transdisciplinary centre brings together leading Australian researchers with partners in Europe, the US and China and industry.

CUDOS - An ARC Centre of Excellence

CUDOS is a collaborative research program between the University of Sydney, the Australian National University, Macquarie University, Swinburne University of Technology, Monash University, RMIT University, and the University of Technology, Sydney. CUDOS is funded from 2011 to 2017 by an Australian Research Council (ARC) grant and other sources, totalling in excess of $35 million, and has over 160 researchers, postgraduate students and technical staff. CUDOS' mission is to lead photonics research, which creates a world's best on-chip photonic platform for information transfer and processing technologies.

IPAS - Institute for Photonics & Advanced Sensing

IPAS is one of 5 research institutes at the University of Adelaide. The mission of IPAS is to use the power of light to make the world a safer, healthier and wealthier place. We are doing this by building unique sensors which harness the powerful properties of light to learn about the environment: this might be inside the human body where we are building tools to diagnosis disease, inside an aircraft where we can search for hidden corrosion, inside a nuclear reactor where we want to measure radiation, or mapping methane leaks. IPAS has a transdisciplinary vision which brings together physicists, biologists, material scientists and chemists so that we can not only do the fundamental experiments that lead to new understanding, but that we also have the range of expertise and facilities to deliver prototype products.

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MQ Photonics Research Centre

The MQ Photonics Research Centre is a Macquarie University Research Centre with approximately 30 academic staff and approximately 30 research students (mostly PhD). The Centre was formed from Macquarie University's Concentration of Research Excellence (CORE) in Lasers and Photonics. It incorporates the Centre for Lasers and Applications (CLA; established in 1988 by the Australian Research Council as a Commonwealth Special Research Centre).

SPIE - The International Society for Optics and Photonics

SPIE, the international society for optics and photonics, was founded in 1955 to advance light-based technologies. Serving more than 256,000 constituents from approximately 155 countries, the not-for-profit society advances emerging technologies through interdisciplinary information exchange, continuing education, publications, patent precedent, and career and professional growth. SPIE annually organizes and sponsors approximately 25 major technical forums, exhibitions, and education programs in North America, Europe, Asia, and the South Pacific. SPIE provided $3.2 million in support of education and outreach programs in 2013.

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Notes

The Braggs: Atrium for Reception and Social Dinner, Lecture Theatre for Plenaries
Union House: Rumours Cafe Level 6 for meals
Physics: P121 and Kerr Grant Lecture Theatre on Level 1 for breaks and presentations
The Hub: Mezzanine for Poster Session, Industry Night, and Photography Competition
Barr Smith Lawns: Emergency Evacuation Point, Social Day Meeting Point


The Optical Society presents

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23–28 November

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Conference Schedule

	Sunday 23rd	Monday 24th	Tuesday 25th	Wednesday 26th	Thursday 27th	Friday 28th
7:30 AM		Breakfast *Rumours Cafe*	Breakfast *Rumours Cafe*	Breakfast *Rumours Cafe*	Breakfast *Rumours Cafe*	Breakfast *Rumours Cafe*
8:00 AM						
8:30 AM						
9:00 AM		Welcome and Plenary **Andre Luiten** *Braggs Lecture Theatre*	Plenary **Peter Delfyett**	Social Day and Conference Banquet *McLaren Vale* *(Meet on the Barr Smith Lawns)*	Plenary **Peter Veitch**	Plenary **John Tisch**
9:30 AM						
10:00 AM		Morning Tea - *Physics 121*	Morning Tea - *Physics 121*		Morning Tea - *Physics 121*	Morning Tea - *Physics 121*
10:30 AM		Presentation M1.1 - *Kerr Grant*	Presentation Tu1.1 - *Kerr Grant* Presentation Tu1.2		Presentation Th1.1 - *Kerr Grant* Presentation Th1.2	Presentation F1.1 - *Kerr Grant* Presentation F1.2
11:00 AM		Presentation M1.2 Presentation M1.3	Presentation Tu1.3		Presentation Th1.3	Presentation F1.3
11:30 AM		Presentation M1.4	Presentation Tu1.4 Presentation Tu1.5		Presentation Th1.4 Presentation Th1.5	Presentation F1.4 Presentation F1.5
12:00 PM		Presentation M1.5 Presentation M1.6	Presentation Tu1.6		Presentation Th1.6	Presentation F1.6
12:30 PM		Lunch *Rumours Cafe*	Lunch *Rumours Cafe*		Lunch *Rumours Cafe*	Lunch *Rumours Cafe*
1:00 PM	Registration *Braggs Atrium*					
1:30 PM		Presentation M2.1 - *Kerr Grant*	Presentation Tu2.1 - *Kerr Grant*		Presentation Th2.1 - *Kerr Grant*	Presentation F2.1 - *Kerr Grant*
2:00 PM		Presentation M2.2 Presentation M2.3	Presentation Tu2.2 Presentation Tu2.3		Presentation Th2.2 Presentation Th2.3	Presentation F2.2 Presentation F2.3
2:30 PM		Presentation M2.4 Presentation M2.5	Presentation Tu2.4 Afternoon Tea - *Physics 121*		Presentation Th2.4 Presentation Th2.5	Presentation F2.4 Presentation F2.5
3:00 PM		Afternoon Tea - *Physics 121*	Presentation Tu3.1 - *Kerr Grant*			Closing Address - *Physics 121*
3:30 PM		Presentation M3.1 - *Kerr Grant* Presentation M3.2	Presentation Tu3.2 Presentation Tu3.3		Scientific Photography Competition *Hub Mezzanine*	Lab tours *Braggs Building*
4:00 PM		Presentation M3.3	Presentation Tu3.4			
4:30 PM		Presentation M3.4 Presentation M3.5				
5:00 PM			Industry Night *Hub Mezzanine*			
5:30 PM		Poster set-up time - *Hub*			Prize Presentation	
6:00 PM	Dinner and Reception *Braggs Atrium*	Dinner *Rumours Cafe*		Dinner *Rumours Cafe*	Conference Dinner BBQ *Braggs Atrium*	Informal Dinner *TBA Local Venue*
6:30 PM						
7:00 PM		Poster Session *Hub Mezzanine*	Dinner *Rumours Cafe*	Social night *Wheatsheaf Hotel* *(Meet on the Barr Smith Lawns, catch Tram to venue)*		
7:30 PM						
8:00 PM						
8:30 PM						
9:00 PM						