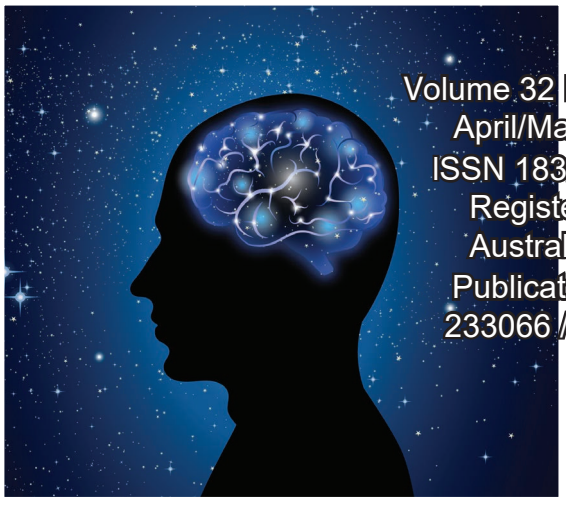
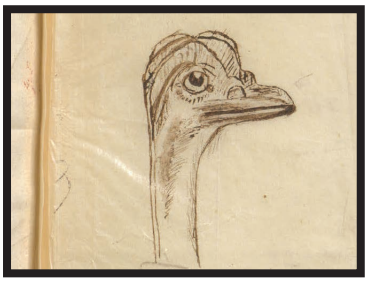
AOS News



Volume 32 Issue 1
April/May 2018
ISSN 1832-4436
Registered by
Australia Post
Publication No:
233066 / 00032

AUSTRALIAN OPTICAL SOCIETY



Laser & Photonics Instruments

Delay Generators & DPSS Nd:YAG Lasers

Jewel DPSS Lasers

- ✔ Energy of 1mJ to 10mJ
- ✔ Rep rates of 5Hz-20Hz
- ✔ 266, 355, 532, 1064 nm

Digital Delay Pulse Generators

- ✔ Timing steps of 1ns to 5ps
- ✔ 2, 4, or 8 Channel Outputs
- ✔ Benchtop, Board or Rackmounted

Quantum® COMPOSERS

Proudly Distributed in
Australia and New Zealand by:

Lastek

Photonics Technology Solutions

AUSTRALIAN OPTICAL SOCIETY ABN 63 009 548 387

AOS News is the official news magazine of the Australian Optical Society. Formed in 1983, the Society is a non-profit organisation for the advancement of optics in Australia. Membership is open to all persons contributing to, or interested in, optics in the widest sense. See the back page (or the AOS website) for details on joining the Society.

Submission guidelines

The AOS News is always looking for contributions, especially from AOS members. Here is a short summary of how to make a submission.

Call for submissions!

Please consider writing something for the next issue.
We are looking for:

Scientific articles on any aspect of optics

Review articles on work in your lab

Conference reports from meetings you attend

Articles for the Optics in Everday Life section

General interest articles

How can you submit?

► The easiest way is by email. We accept nearly all file formats. (Famous last words!).

► Submitted articles will be imported into an Adobe InDesign file. It is best if the diagrams and other graphics are submitted as separate files. All common graphics formats are acceptable, but the resolution must be in excess of 300d.p.i.. Be aware that all colour diagrams will be rendered in grayscale, so if you do use colours, choose colours that show up well in grayscale.

► When using Greek letters and mathematical symbols, use font sets such as Symbol or MT Extra. Please avoid using symbols that are in Roman fonts, where the Option or Alt key is used; e.g. Opt-m in Times font on the Mac for the Greek letter mu.

► If using TeX, use a style file similar to that for Phys Rev. Letters (one column for the title, author and by-line, and two for the main body). The top and bottom margins must be at least 20mm and the side margins 25mm. Submit a pdf file with the diagrams included (no page numbers), as well as copies of the diagrams in their original format in separate files.

► If using a word processor, use a single column. If you do include the graphics in the main document, they should be placed in-line rather than with anchors, but must be submitted separately as well.

What can you submit?

- Scientific Article: A scientific paper in any area of optics.
- Review Article: Simply give a run down of the work conducted at your laboratory, or some aspect of this work.
- Conference Report
- General Interest Article: Any item of interest to members such as reports on community engagement, science in society, etc.
- Article for Optics in Everyday Life section: An explanation of the optics behind any interesting effect, phenomenon, or device.
- News Item
- Obituary
- Book Review
- Cartoon or drawing
- Crossword or puzzle

Reviewing of papers

On submission of a scientific or review article you may request that the paper be refereed, and if subsequently accepted it will be identified as a refereed paper in the contents page. The refereeing process will be the same as for any of the regular peer reviewed scientific journals. Please bear in mind that refereeing takes time and the article should therefore be submitted well in advance of the publication date.

SOUTHERN PHOTONICS

A NEW Femtosecond Fibre Laser

An all-PM fibre laser system designed as a high reliability femtosecond laser system producing high peak power in a compact package.

For nonlinear microscopy and materials surface processing

Key Features:

- Robust all PM fibre construction
- No saturable absorber
- No free space optics
- Self starting
- Variable repetition rates

Raymax LASERS

Raymax Applications Pty Ltd
e: info@raymax.com.au
t: 02 9979 7646
w: www.raymax.com.au

Submission Of Copy:
Contributions on any topic of interest to the Australian optics community are solicited, and should be sent to the editor, or a member of the AOS council. Use of electronic mail is strongly encouraged, although submission of hard copy together with a text file on CD will be considered.

Advertising:
Potential advertisers in AOS News are welcome, and should contact the editor.
Rates: Colour pages $345, Black and White pages $175, with a surchargee for choosing a specific page for the ads (rates excl. GST). 1-2 Black and White pages in the main body of the newsletter are free to corporate members.

Copy Deadline
Articles for the next issue (June/July 2018) should be with the editor no later than 18 Jun 2018, advertising deadline 11 Jun 2018.

Editor
Jessica Kvansakul
La Trobe Institute for Molecular Science
La Trobe University
Melbourne VIC 3086
jk.aosnews@gmail.com

AOS News is the official news magazine of the Australian Optical Society. The views expressed in AOS News do not necessarily represent the policies of the Australian Optical Society.

Australian Optical Society website:
http://www.optics.org.au

- News
- Membership
- Optics links
- Prizes/awards
- Conferences
- Jobs/Scholarships
- Affiliated societies
- ...and more

April/May 2018 Volume 32 Number 1

Articles

Departments

Cover Pictures:

- (Top left and right) Photonics can be used in the journey from the human brain to creating neuromorphic chips in the strive for artificial intelligence based devices that mimic neural processing. Algorithms based on fractals improve efficiencies in this process, see page 27. Images created by Freepik.
- (Centre) Students attended the 10th IONS KOALA conference, which was held at the University of Queensland from 26 November to 1 December 2017, see page 9.
- Insets (left to right)
  - Sir Thomas Browne was the first person to write about popular science in the 17th century, including experiments involving an ostrich, see page 21. Image: Ostrich head drawn by Browne. Manuscripts in English on paper written by Sir Thomas Browne collected by Sir W Osler.
  - ANZCOP 2017 was a huge success, see page 12 for a full report.

AUSTRALIAN OPTICAL SOCIETY

AOS Executive

PRESIDENT
Simon Fleming
School of Physics
University of Sydney
Faculty of Science
Sydney, NSW 2006
Telephone: 02 9114 0851
simon.fleming@sydney.edu.au

VICE PRESIDENT
John Harvey
Southern Photonics
Level 4, 385 Queen Street
Auckland 1010, New Zealand
Tel: +64 9 3076248
j.harvey@southernphotonics.com

PAST PRESIDENT
Stephen Collins
Eng & Sci - Footscray Park campus
Victoria University, PO Box 14428
Melbourne, VIC 8001
stephen.collins@vu.edu.au

SECRETARY
Dragomir Neshev
Nonlinear Physics Centre, RSPE
Australian National University
Canberra, ACT 2601
Tel: 02 6125 3792
dragomir.neshev@anu.edu.au

TREASURER
Arnan Mitchell
Director, Micro Nano Research Facility
RMIT University
Melbourne, VIC 3000
Tel: 03 9925 2457
arnan.mitchell@rmit.edu.au

AOS Councillors

Ken Baldwin
Laser Physics Centre, RSPE
Australian National University
Canberra, ACT 2601
Tel. 02 6125 4702
kenneth.baldwin@anu.edu.au

Frederique Vanholsbeeck
Department of Physics
University of Auckland
Auckland 1010, New Zealand
Tel: +64 9 923 8881
f.vanholsbeeck@auckland.ac.nz

Daniel Gomez
Department of Applied Chemistry and Environmental Science
RMIT University
Melbourne, VIC 3000
Tel: 03 9925 9015
daniel.gomez@rmit.edu.au

Benjamin Eggleton
Director, CUDOS
School of Physics
University of Sydney
Sydney, NSW 2006
Tel: 02 9351 3604
benjamin.eggleton@sydney.edu.au

Halina Rubinsztein-Dunlop
Department of Physics
University of Queensland
Brisbane, QLD 4072
Tel: 07 3365 3139
halina@physics.uq.edu.au

Heike Ebendorff-Heidepriem
Department of Physics
University of Adelaide
Adelaide, SA 5005
Tel: 08 8313 1136
heike.ebendorff@adelaide.edu.au

Michael Steel
Department of Physics and Astronomy
Macquarie University
Sydney, NSW 2109
Tel: 02 9850 8916
michael.steel@mq.edu.au

STUDENT REPRESENTATIVE
Thomas Gretzinger
Department of Physics and Astronomy
Macquarie University
Sydney, NSW 2109
thomas.gretzinger@hdr.mq.edu.au

INDUSTRY REPRESENTATIVE
John Grace
Raymax Lasers
Sydney, NSW 2102
Tel:02 9979 7646
johng@raymax.com.au

Affiliates: OSA and SPIE

Corporate Members

Coherent Scientific
CUDOS
EzziVision
Laser SOS
Lastek
LightOptronics Aust.
Miriad Technologies
Raymax Lasers
Warsash Scientific

President's Report

I have just returned from a very interesting meeting in Canberra organised by Science and Technology Australia (STA), which brought together the Presidents of many similar societies. AOS is a member of STA and part of the membership subscription of full Australian members pays for our membership of STA. I want to tell you a bit about this meeting and STA, both because the topic itself is very important, and because influencing local political priorities and policies is a critical role for national organisations such as AOS that cannot realistically be performed by the big international societies like our partners OSA and SPIE.

In many ways we live in depressing times for science. On the one hand we have fake news and public loss of confidence manifested by rise in climate denial, anti-vaxxers, flat-earthers even. On the other hand, politicians global and local and their policies, seem to be less and less informed by science; Australia doesn't even have science minister.
STA brings together many societies like our own, representing 70,000 Australian scientists and technologists. This provides the opportunity to call as one loud, non-partisan voice for science to be a priority platform for the major parties' campaigns in the next federal election.

STA will be providing assistance for member societies to engage in the promotion of science, and we will pass that on to you. I encourage you to look at what STA is doing, and to yourself engage. Most of us are on social media and are presumably "trusted and informed sources" within our social media networks. We have seen how misinformation influences people and politics on a large scale over social media. We have the opportunity to also exert influence, and using real facts, across our social networks. Please use your social media influence to raise the profile of Australian science and the understanding of why it is important.

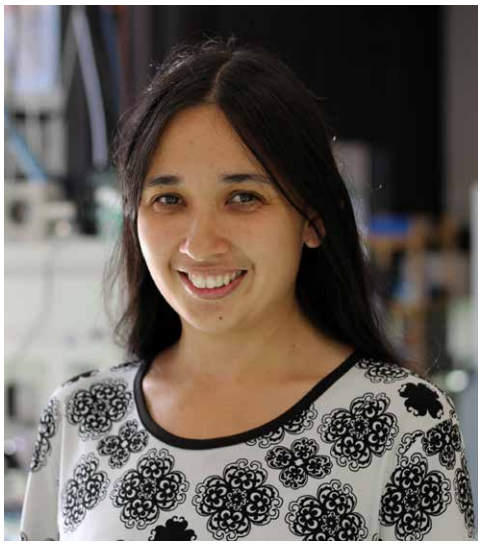
There is excellent progress with our conferences for 2018 and 2020. The AOS Conference, together with ACOFT, will be part of the AIP Congress in Perth in December, and this is rapidly taking shape now, and it will be a great opportunity for the Australian and New Zealand optics and photonics community to get together. Abstract submissions close 15th June. AOS members are also organising focus sessions on special topics. In August 2020 we will host the major regional conference CLEO Pac Rim at the new Sydney convention centre. This is a major undertaking and should be a memorable event. We have now formed the Local Organising Committee and appointed the Technical Program Committee chairs. The website should be live by the time you read this.

I am delighted to advise that Arnan Mitchell has volunteered to take over the role of Treasurer. Thank you Arnan for your willingness to serve the AOS in this role.

I expect that this will be too late for the current year, but there is also a general point to bear in mind. We were disappointed in the lack of diversity, especially gender diversity, in the applicants for the AOS Prizes. I am sure we all know male and female high achievers and worthy applicants. However, the well-known problem that generally women put themselves forward less than men, gave us a pool of applicants that would have inevitably resulted in us perpetuating an embarrassingly male list of prize winners. I consider it the responsibility of the entire community to address this: women please apply, men encourage female colleagues to apply.

Simon Fleming
AOS president

Editor's Intro



Welcome to another issue of AOS News. Apologies for the delay in this issue reaching you. We have a number of articles ranging from details of conferences that took place at the end of 2017 to an item about the inventor of popular science. There is also a report on smartphone image sensors and an article about how fractals can be used in photonics and energy storage. Our 'Optics in Everyday Life' section looks at mirages and Tony Klein has come up with a brief quiz as something new. I hope you enjoy reading them all. As usual, please let me know if you have any suggestions for anything you would like to see in AOS News or have any articles or other items you would like to submit.

I read a number of interesting articles recently in Nature news and comments about diversity and leadership within labs and how these relate to productivity. There are a number of related but different points to consider. One is that it is good to have diversity within groups and to have underrepresented people involved and given opportunities. To help increase participation from diverse groups biases need to be understood and overcome so that everyone has the same opportunity. Some of the solutions suggested were changing the wording of job advertisements so they don't include words such as 'excellent' and 'outstanding' as this can make those from underrepresented groups less likely to apply for the position. They often experience 'imposter syndrome' and don't feel that they should apply for something requiring such a stellar candidate. Another proposal was specific mentoring for people from these groups as well as making sure selection committees are mixed in both race and gender so that candidates don't feel completely alienated during interviews. Taking student backgrounds into account when choosing those appropriate to continue on to postgraduate study was a further suggestion as first-in-family and those from a low socio-economic background have often overcome significant challenges to get to university in the first place, and may need additional support to help them succeed and take steps that are likely to lead to postgraduate positions.

When people from minority groups are given positions it was also suggested that it is important to make sure they don't feel isolated. Having a 'critical mass' of people with different backgrounds helps everyone feel welcome and able to see where their individual skills add to the success of the group. This includes those with disabilities and sexual orientations as these groups are often overlooked in campaigns to help women and minorities. Inclusivity and being an ally were the other goals to strive for to help recruit and retain people from diverse backgrounds. The need for improvements in inclusivity were highlighted by a related article about how increases in diversity may lead to better output. This could be due to the greater number of perspectives involved, better representation of communities, or just that working with a diverse team means that people have to be careful and precise with communication to avoid confusion.

A separate issue relating to productivity and healthy lab cultures is the fact that group leaders often don't receive specific leadership training but that this would be beneficial. Nature surveyed over 3200 scientists across the world and found that lack of management training is a strong factor in the development of an unhealthy lab culture. Most scientists taking part in the survey said that their lab groups were healthy, but around 14% of junior respondents had negative views. Everyone agreed that training courses for principal investigators would be good. Although this is the case, there are only a few places that run specific mentoring and management courses for lab heads, and these are not compulsory. Training in how to manage a group would be beneficial and there were suggestions from some respondents that some form of training should be a requirement and not optional. It is something that would be a big help since being a good scientist doesn't automatically make one a good leader. Even if advice and mentoring has been given to new lab heads previously, specific training in running a lab and the management and leadership skills involved in this seem like a really good idea.

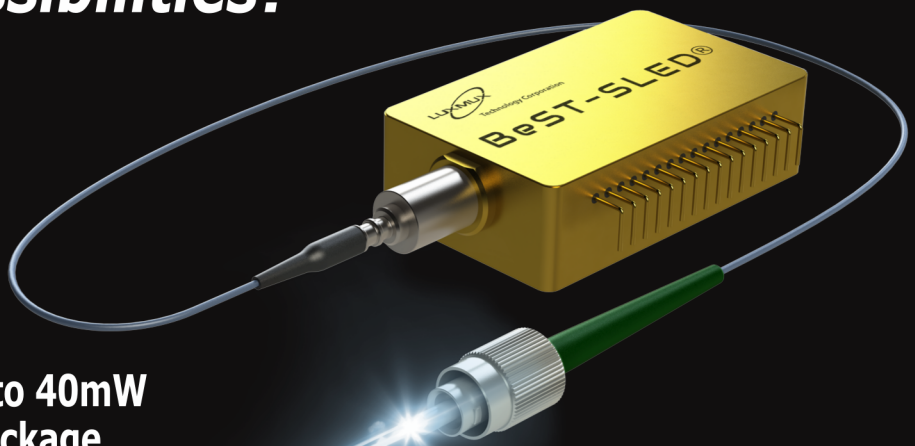
I hope you enjoy this issue of AOS News,

Jessica Kvansakul
Editor

LUXMUX

New Light Source for Fiber Bragg Grating (FBG) Sensors

More Data. More Coverage. What are the Possibilities?

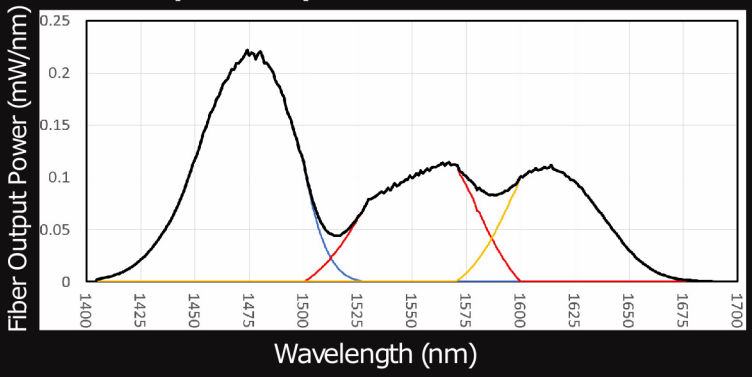


BeST-SLED® Advantages

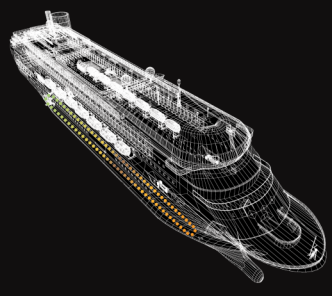
- FWHM up to 480nm
- Fiber output power of up to 40mW
- Up to 6 SLEDs in one package from 1240nm to 1720nm

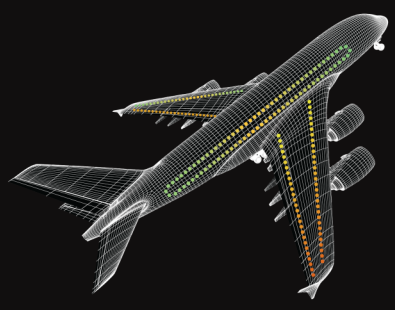
Luxmux's BeST-SLED® is an ideal light source for fiber optic sensing applications. With our broader spectrum, and higher power, users can increase the number of FBG's, and deploy longer fibers. BeST-SLED® - More compact. More powerful. More cost-effective.

Example ASE spectrum from a 3 SLED unit



Fiber Bragg Grating sensors are used to measure strain, temperature, and pressure in appilcations such as civil engineering, structural analysis material engineering, transportation, infrastructure.





LUXMUX

Warsash Scientific
Advanced Instruments for Research & Industry
t: +61 2 9319 0122 sales@warsash.com.au
f: +61 2 9318 2192 www.warsash.com.au

Amplitude SYSTEMS

Tangor

High power femtosecond laser

Main specifications:

Pulsed energy >300 µj

Average Power >100W

Repetition rate 0-2MHz

Pulse duration <500 fs<

Tangor takes ultrafast technologies a step forward, providing unprecedented average power with an extremely short pulse duration housed in an ultra-compact footprint

Tangor brings industrial productivity to the most advanced ultrafast micro-processing applications. It small size and complete computer control capability allows for easy integration in micro-processing systems.

Optional pulse duration adjustment and harmonic generation further extend the application range.

For more information on Amplitude systems
Raymax Applications Pty Ltd
t: 02 9979 7646 e: info@raymax.com.au

IONS KOALA 2017

by W Y Sarah Lau

The Conference on Optics, Atoms and Laser Applications (KOALA) is an annual event that operates around Australia or New Zealand as a part of the Optical Society's International OSA Network of Students (IONS) programme.

IONS KOALA 2017 was held at the University of Queensland's St Lucia Campus from 26 November – 1 December 2017 by the combined efforts of the University of Queensland OSA Student Chapter and the Optics Physics and Engineering (OPE) Griffith University Student Group, a joint OSA and SPIE Student Chapter. This conference series is now the largest conference in the Australasian region organised for students, by students, and brings together Honours, Masters and PhD students from Australia, New Zealand and the world working in optics-based fields. KOALA aspires to foster an environment where young researchers can share their expertise, discuss new ideas, relax, and socialise, while building long-lasting networks that will continue to support them throughout their careers.

This year's delegation consisted of 82 students, representing 23 institutions from 11 different countries. We were also lucky enough to be joined by Sebastian Schnelle, the 'founder' of KOALA back in 2008, who brought our international contingent to 13 delegates – the largest the conference series has seen, including attendees from Canada, Romania, Latvia, France, China, the Philippines, India, United Kingdom, Germany and Hong Kong. This was only possible due to the kind support of our sponsors which allowed us to offer seven international travel grants as well as 15 domestic (Australia and New Zealand) travel grants. We had 66 students from Australian institutes and four from New Zealand.

As with every year, IONS KOALA attracts students from diverse backgrounds and areas of expertise, thereby bringing together students who may otherwise be unlikely to meet. It also presents the added challenge of presenting their research, in either an oral or poster presentation, to non-experts – an essential skill. This year's topics included Bose-Einstein condensates, ion traps, integrated photonics, optomechanics, superconducting circuits, quantum information, quantum measurement and control, metamaterials, biophotonics, biomedical applications of lasers, imaging, metrology, spectroscopy, micro and nanofabrication, waveguides and organic solar cells.

A new focus of the programme for IONS KOALA 2017 was professional development. In total there were four new events, each aimed developing the students' skills for engaging with the world as mature scientists. *Networking 101* helped with preparing them for making genuine connections with people; *The Role of Experiments in Quantum Theory* challenged the attendees in terms of engagement with our scientific community and how it all relates; *A Night with the Postdocs* gave students an honest insight to paths in academia through hearing stories and advice from academics with the opportunity to ask frank questions; and *The Optics Suitcase* highlighted the importance of educational outreach and showcased the Optical Society's outreach tool. We were also very fortunate to be joined by an IBM researcher for insights to work in industry, along with other sponsor representatives, at the *Industry and Innovation Evening*.

The Koala and Kiwi mascots get passed between conferences and every year a new patch is added to them to mark the conference. They also join for every event – here they wait while students continue mingling after a night event.

Students listening to Anna Pham, IBM Research Scientist, sharing how the skills she gained during her PhD at the Large Hadron Collider equipped her for her current position at IBM during the EQUS Industry and Innovation Evening.

A group photo of the delegates for IONS KOALA 2017 – near where the first photo was taken 10 years ago with less than half the number of students!

We are glad to have featured four plenary speakers, thanks to the help of the Optical Society and SPIE. Denise Zezell, Head of the Laser Applications Department at Nuclear and Energy Research Institute (IPEN-CNEN/SP) in Sao Paulo, Brazil, presented her work in using optics for diagnostics

The IONS KOALA 2017 Organising Committee, a collaboration between students from the University of Queensland and Griffith University.

and therapeutic treatments in medicine and dentistry. Andrew Forbes from the University of Witswatersrand, South Africa, showed us how he makes structured light on-demand directly from the source, using techniques such as spatial light modulator lasers with holographic mirrors to spiral lasers for twisted light. Jessica DeGroote Nelson of Optimax Systems Inc. revealed the power and benefits of freeform optics while Howard Wiseman, Director of the Centre for Quantum Dynamics at Griffith University, highlighted the elegance of the foundational principles that make a laser what it is.

In addition to our four plenary speakers, two of whom were generous enough to stay for the duration of the conference and have thoughtful conversations with the students, we had a strong focus on the newest research through student talks. We continued with the poster previews that were introduced in IONS KOALA 2016 although reduced the timeslot to just 90 seconds. The challenge to bring maximal attention in minimal time was a fun and engaging introduction to the discussion-filled poster session that followed that night.

As per tradition, there were several social events to the IONS KOALA programme to facilitate networking and build a welcoming and friendly atmosphere for the conference. The conference kicked off with a trivia night to help delegates meet each other and warm up their minds for the intense week ahead. Halfway through the conference we had a day tour of the gorgeous North Stradbroke Island for our social day – a chance for the host city to show off the best it has to offer! We saw dolphins at Amity Point, had lunch at the Stradbroke Island Beach Hotel and enjoyed the North Gorge Headland Walk in the company of sea cliffs, wallabies, turtles and eagle rays. On Thursday evening we made our way to the conference dinner at Navala Churrascaria by cruising down the Brisbane River on a CityCat, enjoying the city sights along the way. The famous Brazilian BBQ was a great way to wrap up the conference and celebrate its 10th anniversary in style!

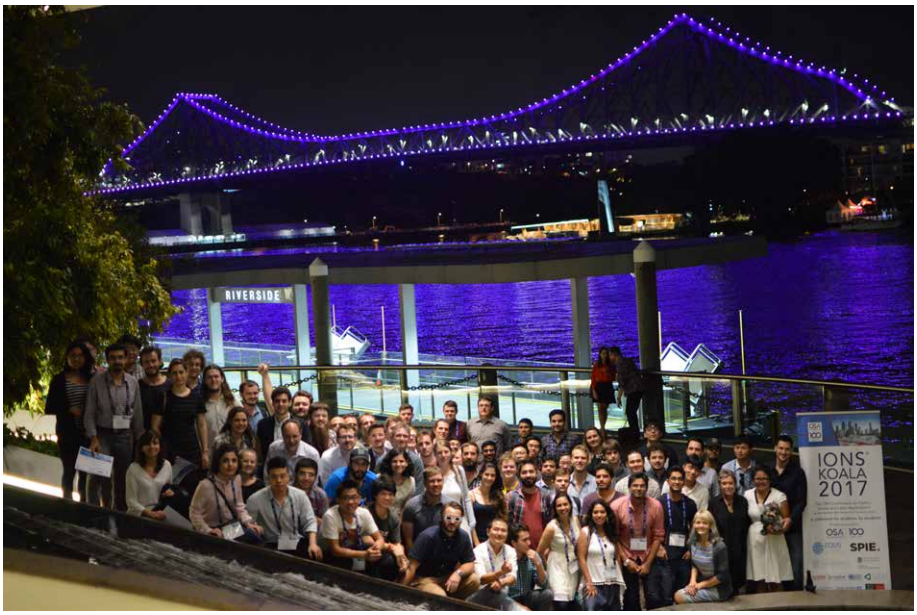
Talking to people throughout the week and from the survey collected at the end of the conference, delegates had an enjoyable and rewarding (albeit a little tiring!) week. We were glad to receive comments regarding our focus on diversity: in addition to having a wide representation of different countries and topics, we also had 3 female speakers out of 5 invited talks (including that for our Industry and Innovation Evening)! The Night with the Postdocs and Industry and Innovation Evening were identified as the most beneficial and enjoyable events where students could access information and contacts regarding their pathways post-studies.

Our thanks extend to all the delegates who joined us to share their research and foster friendships, the invited speakers for their time and, of course, to our sponsors, without whom none of this would have happened!

We are very proud to have hosted the 10th instalment of KOALA and see its return back to where it started in 2008. IONS KOALA 2018 will continue to Sydney, hosted by Macquarie University and the University of Sydney and chaired by Thomas Gretzinger. We look forward to another successful event!

Along the North Gorge Headland Walk at North Stradbroke Island where attendees were in the presence of wallabies, sea turtles, eagle rays and spectacular (albeit a bit cloudy!) views of South East Queensland.

WY Sarah Lau is with the School of Mathematics & Physics, University of Queensland.



IONS KOALA 2017 wrapped up with our conference dinner along the river, where we celebrated the 10th anniversary of the conference series in style!

ONE MEMBERSHIP

Infinite Possibilities

OSA Membership is an investment in your future—with professional benefits and vital connections that can last your entire career. That's why leaders in science, engineering and industry choose The Optical Society as their professional association.

As a member, you will gain access to an unparalleled, international network and the highest-caliber research. From the latest discoveries and news to members-only events and technical groups, The Optical Society is the organization of choice for leading professionals in optics and photonics, like you.

Get started. osa.org/join

MICHAL LIPSON
Israel

ALVARO CASAS BEDOYA
Colombia

The 3rd Australia New Zealand Conference on Optics and Photonics (ANZCOP)

by Litty V Thekkekara

Every other year optical researchers in Australia and New Zealand meet to discuss interesting progress and new developments in optics and photonics at ANZCOP. In 2017 the event took place in New Zealand.

Queenstown, New Zealand

ANZCOP is one of the major conferences conducted by the Australian Optical Society (AOS), bringing researchers in optics and related fields together for a week to explore new advances in the field. It also provides opportunities to meet people who talk the same research language and raises the potential for collaborations. The third meeting of the ANZCOP series was held from 4 to 7 December in 2017, in association with The Dodd Walls Centre for Photonic and Quantum Technologies. It took place in the enticing city of Queenstown in the South Island of New Zealand which seems to be a perfect place for a year-end conference. The meeting incorporates the Australian Conference on Optics, Lasers, and Spectroscopy (ACOLS) and the Australian Conference on Optical Fibre Technology (ACOFT).

The conference brought around 200 participants, including invited speakers from USA, Europe, and Japan. It kicked-off with a welcome reception on the Sunday evening at the Rydges Lakeland Resort.

On day one, Professor Albert Polman, Frew Fellow from the FOM Institute AMOLF, Amsterdam gave the first keynote presentation on modern spectroscopy and nanomaterials as well as lab to commercial product translation. I was very excited to hear him since he has been involved in the development of nanophotonics and photovolatiacs for many years. The talk was followed by a presentation by Andrea Blanco-Redondo from University of Sydney, who was the recipient of the Geoff Opat Early Career Researcher prize in 2016 for her work on solitons in photonic waveguides.

Some of the primary focuses of the conference were on metasurfaces, biophotonics, quantum technologies and the LIGO project. It was fascinating to hear about the detection of gravitational waves and the plans for the development of technologies based on gravitational waves. There were also a lot of talks focusing on metasurfaces for future quantum optics related technologies which clearly shows one direction of the future of optics.

The interaction with authorities of relevant fields from around the world is a life-long memorable experience. The quality of talks given by all speakers was exceptionally high and gave a general view of significant developments in Australian optical research.

Personally, I always like to visit the posters where exciting research can be found. The poster sessions of the conference were conducted on the Monday and Wednesday evenings and introduced wide areas of research along with the beers. The post-deadline session which happened on the Monday evening after the posters was a bit challenging

Welcome reception

Albert Polman during his keynote speech

Industry session

for people to stay after the productive live session, but the hall still had enough attendees.

The industrial session was another major event of the conference which occurred on the Tuesday evening. The six industrial people, from start-ups to established companies shared their experiences about the transition from academic life to the more challenging industrial world. The forum which took place after the talks from the speakers discussed platforms that need to be developed for the translation of laboratory research to a commercial product and the support researchers require in that process. It is appreciable that already some of the Australian and New Zealand institutions have initiated the path of US universities in that aspect.

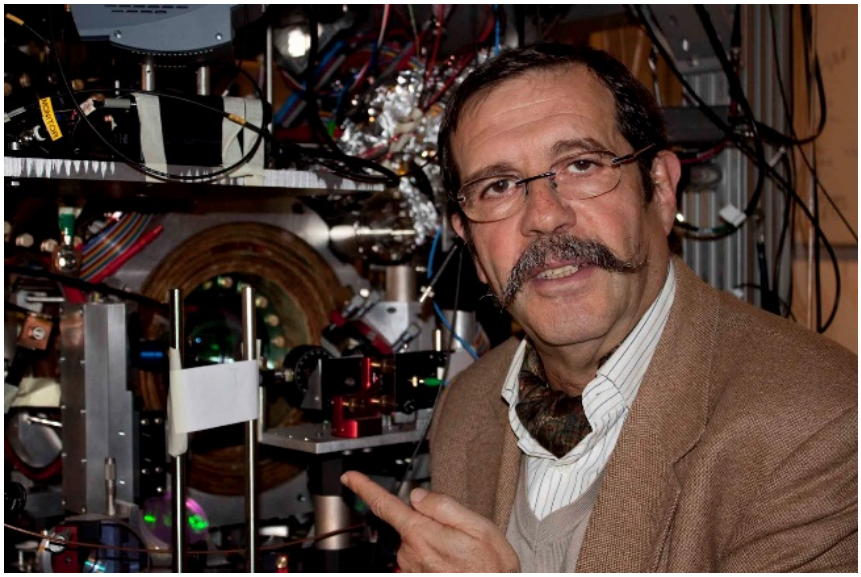
The public lecture of the conference took place on Wednesday 6th December in the Memorial townhall where Professor Alain Aspect, one of the pioneers of quantum optics gave a talk on the origin of quantum optics and the history of modern quantum technology development and the challenges that needed to be overcome. It was amazing to hear directly from an excellent researcher who we know from textbooks.

Conference leisure time was delightful and offered opportunities for networking as well time to ask more about research in detail which might not be possible during actual presentations due to question time limitations.

One of the tremendous parts of the event was the Gala dinner which took place at a resort away from the conference venue. It is a time when the hierarchical orders between researchers disappear. All of us enjoyed that night due to the luxurious food as well as the most amazing natural scenery.

I also took the opportunity to visit the Dodd Walls Centre for Photonic and Quantum Technologies at the University of Otago, Dunedin campus which gave me an in-depth knowledge of modern quantum technologies in next generation real-world applications. The whole conference was a great experience, offering the chance to hear science in a relaxed atmosphere before getting into the Christmas rush.

Litty V Thekkekara is with the School of Science, RMIT University.



Alain Aspect

Gala Dinner

SPIE.

MEMBERSHIP

A long-term investment that pays off with international connections and professional growth.

Join or Renew your SPIE Membership

Regular Member: **1 year US$125 | 3 years US$350 | Lifetime US$995**
Early Career Professional: **1 year US$55 | 3 years US$150 | Lifetime US$250**
Student Members: **1 year US$20**

- Complimentary SPIE Journal of your choice
- Free online professional development courses
- 10 SPIE Digital Library downloads
- Discounts on events, publications, SPIE Digital Library, and courses
- Exclusive access to Member networking events
- Career advancement and peer recognition
- Complimentary *SPIE Professional* Magazine

Invest in Your Sucess. Join SPIE.

www.spie.org/membership help@spie.org +1 360 676 3290

Conferences

29 July to 3 August , CLEO Pacific Rim 2018

The 13th CLEO Pacific Rim conference will take place at the Hong Kong Convention and Exhibition Centre, Hong Kong SAR from 29 July to 3 August 2018. CLEO Pacific Rim is the preeminent forum in this region reporting on the latest research and development in a wide range of laser and electro-optic disciplines, including fundamental physics of lasers and quantum optics, device development, systems engineering, and applications. Earlybird registration closes 10 June! www.cleopr2018.org

4-8 December, IONS KOALA 2018

The International OSA Network of Students Conference on Optics, Atoms and Laser Applications, IONS KOALA 2018 will be held in Sydney at Macquarie University from Tuesday 4 to Saturday 8 December. The conference is a student-run conference for undergraduate and postgraduate physics students from all around the world. IONS KOALA 2018 is being co-hosted by the OSA student chapters at Macquarie University and the University of Sydney. www.ionskoala.osahost.org

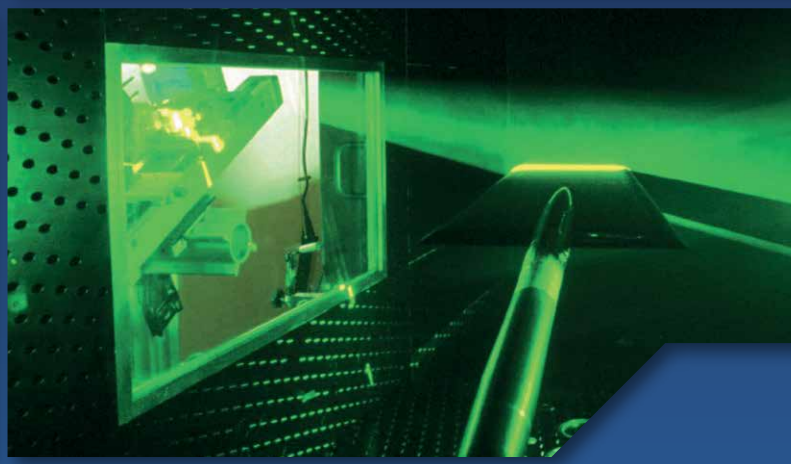
9-14 December, AIP Congress 2018

The Australian Institute of Physics 2018 Congress will be held in Perth from Sunday 9 to Friday 14 December at the University of Western Australia. Following on from the success of the AIP Congress in Brisbane in December 2016, the 2018 congress aims to continue the tradition of being a big celebration of science, at the highest international level. The Organising Committee look forward to welcoming the world of physics and the broader community to a scientifically intense yet socially relaxed celebration of science. The conference incorporates the AOS annual meeting. Abstract submission closes 15 June! www.aip2018.org.au

High Performance Nd:YAG & Tuneable Lasers

Quantel laser

Nanosecond Nd:YAG lasers
Dye lasers & solid state OPOs
Fibre laser for cooling and trapping



Q-smart DPSS laser

NEW

Repetition rates to 200Hz

Highest average power
from oscillator only design

Automated phase matching of harmonics

(08) 8150 5200
sales@coherent.com.au
www.coherent.com.au

Coherent SCIENTIFIC

Pushing the Boundaries of Smartphone Image Sensors by Measuring the Total Ozone Column

by Damien Igoe and Alfio Parisi

Smartphone image sensors allow more than just conventional photography and can be used for a number of scientific applications.

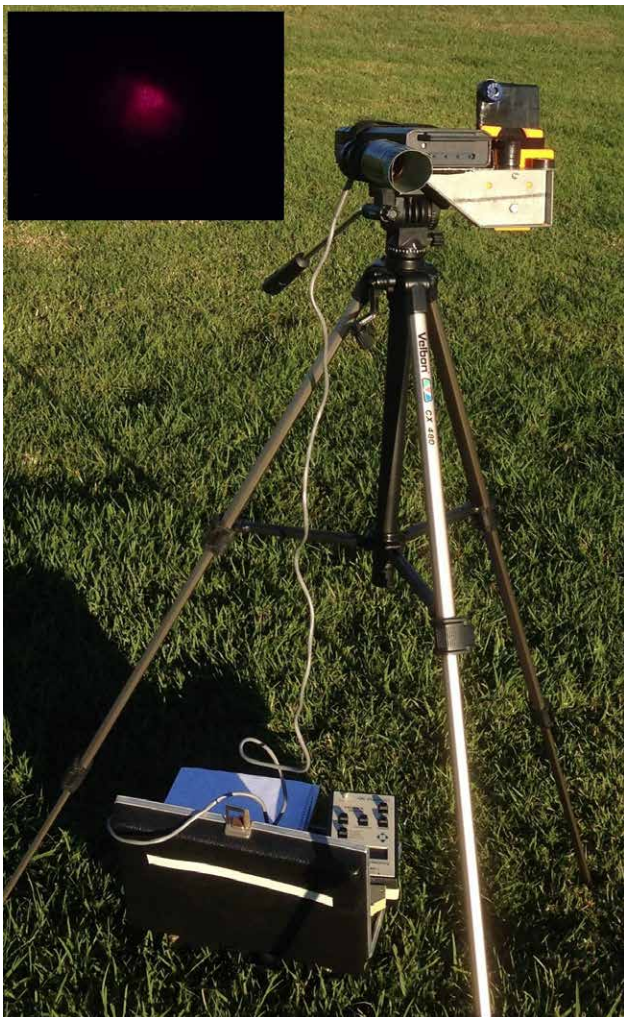
Smartphones are arguably one of the most widely owned and underused technologies existing today. The image sensor that is at the heart of the optical system used as the commonly included camera is a lot more sensitive to sensing the 'invisible world' than most people realise. Research has revealed that the smartphone image sensor is inherently sensitive to ultraviolet radiation, even sensing well into the ultraviolet-B (UVB) wavebands, despite the great amount of attenuation caused by the outer lens of the camera.

As part of long-standing research into using smartphone image sensors to detect and accurately measure solar ultraviolet radiation, a team from the Faculty of Health, Engineering and Sciences, University of Southern Queensland have published the results of a method that takes the measurement and quantification of UVB a step further: by using an unmodified smartphone image sensor with the aid of external narrowband UVB filters (at 305nm and 312nm) to accurately and precisely measure the total ozone column (TOC), essentially to measure the thickness of the Ozone Layer from the ground.

The smartphone image sensor response to incident solar UVB irradiances at 305 nm and 312 nm were calibrated against corresponding observations taken from a Microtops II sunphotometer (manufactured by Solar Light). Each photo of the sun taken through these filters appeared as a pale magenta dot in a sea of dark sensor noise, so a median filter was applied to reduce the background noise and an adaptive threshold developed to isolate the image sensor responses for the solar disk – this image processing was performed using custom made Python scripts. The TOC was then calculated by using the corresponding paired 305/312 nm responses.

The smartphone image sensor measurements were very accurate to a root-mean-square error of 4.3 Dobson Units (the unit of measurement for TOC) when calibrated against the Microtops II sunphotometer, with validation observations being an average of only 3.5% from actual observed values.

The research has significance in that it opens the door for further involvement in participation in atmospheric observations through the use of accessible and inexpensive optical system technology within the ubiquitous smartphone.



Field observation set up: at the top of the tripod, the smartphone (Sony Xperia Z1) is on the right and the Microtops II sunphotometer is in the middle. The top left inset is a sample image of the sun as seen at 305 nm by a smartphone image sensor. The UVB meter on the right of the Microtops (and the attached IL1400 on the ground) were not used in the experiments. (Image credit: A. Amar)

Full reference

Igoe, D. Parisi, A. V. Amar, A. Downs, N. J. and Turner, J. (2018), *'Atmospheric Total Ozone Column Evaluation with a Smartphone Image Sensor'*, International Journal of Remote Sensing, vol. 39, issue 9, pp. 2766-2783

https://doi.org/10.1080/01431161.2018.1433895

Dr Damien Igoe and Professor Alfio Parisi are with the Faculty of Health, Engineering and Sciences, University of Southern Queensland.

Australian Research in the News

Add-on clip turns smartphone into fully operational microscope

Smartphone in use as a microscope with add-on clip. Image courtesy of CNBP/cnbp.org.au.

Australian researchers from the ARC Centre of Excellence for Nanoscale BioPhotonics (CNBP) have developed a 3D printable 'clip-on' that can turn any smartphone into a fully functional microscope. Reported in 'Scientific Reports', the smartphone microscope is powerful enough to visualise specimens as small as 1/200th of a millimetre, including microscopic organisms, animal and plant cells, blood cells, cell nuclei and more. The clip-on technology is unique in that it requires no external power or light source to work yet offers high-powered microscopic performance in a robust and mobile handheld package. The researchers are making the technology freely available, sharing the 3D printing files publicly so anyone – from scientists to the scientifically curious – can turn their own smartphones into microscopes.

Lead developer and CNBP Research Fellow at RMIT University, Dr Antony Orth, believes the technology has immense potential as a scientific tool, one that is ideal for use in remote areas and for field-work where larger standalone microscopes are unavailable or impractical. "We've designed a simple mobile phone microscope that takes advantage of the integrated illumination available with nearly all smartphone cameras," says Dr Orth. The clip-on has been engineered with internal illumination tunnels that guide light from the camera flash to illuminate the sample from behind. This overcomes issues seen with other microscopy-enabled mobile phone devices says Dr Orth. "Almost all other phone-based microscopes use externally powered light sources while there's a perfectly good flash on the phone itself," he explains. "External LEDs and power sources can make these other systems surprisingly complex, bulky and difficult to assemble. The beauty of our design is that the microscope is useable after one simple assembly step and requires no additional illumination optics, reducing significantly the cost and complexity of assembly. The clip-on is also able to be 3D printed making the device accessible to anyone with basic 3D printing capabilities."

A further advantage noted by Dr Orth is that the clip-on enables both bright-field and dark-field microscopy techniques to be undertaken. Bright-field microscopy is where a specimen is observed on a bright background. Conversely, dark-field shows the specimen illuminated on a dark background. "The added dark-field functionality lets us observe samples that are nearly invisible under conventional bright-field operation such as cells in media," he says. "Having both capabilities in such a small device is extremely beneficial and increases the range of activity that the microscope can be successfully used for."

Dr Orth believes the potential applications for the smartphone microscope are enormous. "Our mobile microscope can be used as an inexpensive and portable tool for all types of on-site or remote area monitoring. Water quality, blood samples, environmental observation, early disease detection and diagnosis - these are all areas where our technology can be easily used to good effect." Dr Orth sees significant benefit in developing countries for the device. "Powerful microscopes can be few and far between in some regions," says Dr Orth. "They're often only found in larger population centres and not in remote or smaller communities. Yet their use in these areas can be essential - for determining water quality for drinking, through to analysing blood samples for parasites, or for disease diagnosis including malaria."

To ensure that this technology can be utilised the world over, the files for the 3D printing of the microscope clip-on are being made freely available. They are available for download at the CNBP web site - http://cnbp.org.au/online-tools.

"Ideally, a phone microscope should take advantage of the integrated flash found in nearly every modern mobile, avoiding the need for external lighting and power. It should also be as compact and easy to assemble as possible. It is this design philosophy that inspired us in the development of this add-on clip," says Dr Orth. The new phone microscope has already been tested by Dr Orth and his CNBP colleagues in a number of areas, successfully visualising samples ranging from cell culture, to zooplankton to live cattle semen in support of livestock fertility testing.

Source material: http://cnbp.org.au/-/cnbp/lib/percontent/pdfs/Media_release_Smartphone%20microscope_FINAL.pdf

Original article: A Orth, ER Wilson, JG Thompson & BC Gibson, *A dual-mode mobile phone microscope using the onboard camera flash and ambient light.* Scientific Reports, **8**, 3298 (2018); https://www.nature.com/articles/s41598-018-21543-2

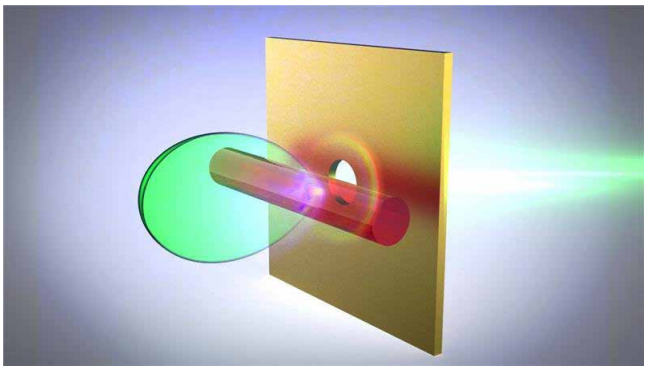
The future of wireless communications is terahertz

Electrical and optical engineers in Australia have designed a novel platform that could tailor telecommunication and optical transmissions. Collaborating scientists from the University of New South Wales in Sydney and Canberra, the University of Adelaide, the University of South Australia and the Australian National University experimentally demonstrated their system using a new transmission wavelength with a higher bandwidth capacity than those currently used in wireless communication. Reported in APL Photonics, from AIP Publishing, these experiments open up new horizons in communication and photonics technology.

Optical fibres are the frontrunners in fast data transmission, with data encoded as microwave radiation. Current microwave wireless networks operate at a low gigahertz frequency bandwidth. In our current digital age that demands speedy transmission of large amounts of data, the limitations of microwave bandwidths become increasingly more apparent. In this study, scientists examined terahertz radiation, offering higher bandwidth capacity for data transmission and providing a more focused signal that

could improve the efficiency of communication stations and reduce power consumption of mobile towers. "I think moving into terahertz frequencies will be the future of wireless communications," said Shaghik Atakaramians, an author on the paper. However, scientists have been unable to develop a terahertz magnetic source, a necessary step to harness the magnetic nature of light for terahertz devices.

The researchers investigated how the pattern of terahertz waves changes on interaction with an object. In previous work, Atakaramians and collaborators proposed that a magnetic terahertz source could theoretically be produced when a point source is directed through a subwavelength fibre. In this study, they experimentally demonstrated their concept using a simple setup - directing terahertz radiation through a narrow hole adjacent to a fibre of a subwavelength diameter. The fibre was made of a glass material that supports a circulating electric field, which is crucial for magnetic induction and enhancement in terahertz radiation.



Aperture in a metallic screen with a dielectric fibre placed on top acting as a magnetic dipole emitter when excited by a wave incident on the aperture. Credit: AE Miroshnichenko.

"Creating terahertz magnetic sources opens up new directions for us," Atakaramians said. Terahertz magnetic sources could help the development of micro- and nanodevices. For example, terahertz security screenings at airports could reveal hidden items and explosive materials as effectively as X-rays, but without the dangers of X-ray ionisation. Another advantage of the source-fibre platform, in this case using a magnetic terahertz source, is the proven ability to alter the enhancement of the terahertz transmissions by tweaking the system. "We could define the type of response we were getting from the system by changing the relative orientation of the source and fibre." Atakaramians said.

Atakaramians emphasised that this ability to selectively enhance radiation isn't limited to terahertz wavelengths. "The conceptual significance here is applicable to the entire electromagnetic spectrum and atomic radiation sources," said Shahraam Afshar, the research director. This opens up new doors of development in a wide range of nanotechnologies and quantum technologies such as quantum signal processing.

Source material: https://publishing.aip.org/publishing/journal-highlights/future-wireless-communications-terahertz

Original article: S Atakaramians, IV Shadrivov, AE Miroshnichenko, A Stefani, H Ebendorff-Heidepriem, TM Monro, S Afshar V. *Enhanced terahertz magnetic dipole response by subwavelength fiber*. APL Photonics, **3**, 051701 (2018); https://doi.org/10.1063/1.5010348

HÜBNER Photonics | Coherence Matters

C-WAVE

Fully automated, tunable CW laser

- IR (900 - 1,300nm)
- Blue (450 - 525nm)
- Orange (540 - 650nm)
- Mod-hop-free tuning >20GHz
- Wavelength accuracy <1MHz with AbsoluteLambda™

Atomic physics | Quantum optics | Photochemistry
Spectroscopy | Biophotonics | Holography | Metrology

Warsash Scientific
Advanced Instruments for Research & Industry
t: +61 2 9319 0122 sales@warsash.com.au
f: +61 2 9318 2192 www.warsash.com.au

The Man Who Invented Popular Science used a 17th-Century Version of Clickbait

This article was originally published on
THE CONVERSATION

by Harriet Phillips

We are living in a golden age of popular science. Multiple television and radio programmes, best-selling books, well-attended science festivals around the world – all reveal the apparently limitless public appetite for learning about science.

Prominent scientists like Richard Dawkins and Steven Pinker write best-sellers explaining the secrets of evolutionary biology and psychology to the public, while the life of the theoretical physicist Stephen Hawking has been the subject of a multiple-award-winning biopic. There is even supposedly a "Brian Cox effect". The books and media appearances of the pop keyboardist-turned-particle physicist, Professor Cox, are credited with a 20% rise in students taking A-level physics in the UK since 2008, and even more astonishingly, a massive 52% increase in applications to study physics at university in the same period.

While this boom might suggest that we are at peak enthusiasm for popular science, the phenomenon is at least as old as the scientific revolution. Doctor, writer, and all-round polymath Thomas Browne (1605-1682) is now better known for his literary work but in his own time was legendary as the greatest – and first – scientific populariser of his day.

Browne's best-selling *Pseudodoxia Epidemica*, or Common Errors, debunked myths in botany, geology, geography, anatomy, and zoology, as well as history and scripture. Going through seven editions during his lifetime and translated into several European languages, it made him the first public "expert" and a pioneer of popular science.

Ostrich head drawn by Browne. Manuscripts in English on paper written by Sir Thomas Browne collected by Sir W Osler.

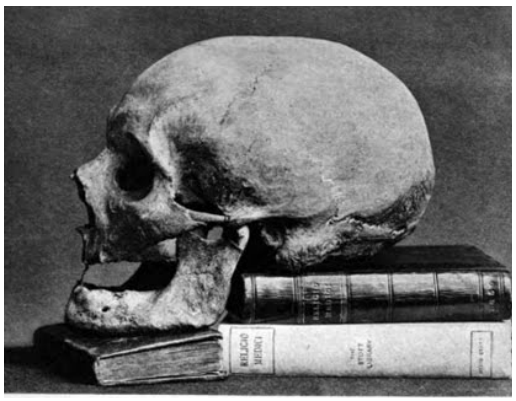
Of ostriches and men

Common Errors is a landmark work of myth-busting. In it Browne tackles important questions such as: do elephants have knees? Why do we say "bless you" when we sneeze? Is the earth a magnetic body? Did Jesus have long hair? Who would win in a fight, a toad or a spider?

These questions were often deliberately provocative, a kind of 17th-century intellectual clickbait. Was the forbidden fruit an apple, he asks (and why, when there are so many nicer and more tempting fruits)? The answer, as is usual for Browne, revolves around complex questions of translation and etymology – but the lead-in is daringly playful. This is typical of the way the book brilliantly introduces its readers to cutting-edge developments in science and other fields of learning. Browne's learning rests on his vast reading and extensive experimental data (his notebooks record much grisly experimentation, including the toad vs spider incident), but it is presented with dazzling flair.

One of Browne's most prolonged experiments involved the ostrich, acquired by his son Edward. A flock arrived in London in the early 1660s, brought by the Moroccan ambassador as a gift for the king, and immediately caused a splash – exotic animals were rare in England at the time.

Edward managed to get hold of one and kept it in his stables. A frenzy of letters between father and son followed,



Browne's skull and books.

discussing its eating and sleeping habits, the shape of its feet, and the noises it made ("a strange odde noyse … especially in the morning and perhaps when hungry"). This experiment in collaborative zoo-keeping came to an abrupt end when the ostrich died in its sleep one night, as Browne had predicted, being unused to the cold of a London January. It was immediately dissected. Browne was nothing if not thorough.

The learned Dr Browne

One of the most striking things about this work was that it was all published in English. At this time most scientific enquiry – or natural philosophy, as it was known – was conducted in Latin, and often circulated in manuscript or privately through social networks. While Browne was a keen letter writer (and fluent Latinist), he made a deliberate decision to make scientific discoveries available in English, and in print. *Pseudodoxia* offered the possibility of being up-to-date, at a time when the frontiers of knowledge were rapidly expanding, to anyone who could read and afford to buy a book. While this was still a limited category, it represented a huge advance in the potential for the public understanding of science.

In anglicising science for a general readership, he also invented some of its key terms. Browne introduced over 700 words to the English language, many of them in the pages of *Pseudodoxia*. His

Portrait of Sir Thomas Browne by Robert White. Credit: Wellcome Collection. CC BY

coinages include "medical", "electricity", "hallucination", "incisor", "carnivorous", "coma", "migrant", and (fittingly) "misconception". Rapidly adopted by celebrated scientific contemporaries like Robert Hooke (1635-1703) and Robert Boyle (1627-1691), he had a lasting effect on the vocabulary of science with these words.

It was this influence on which his reputation was built. Celebrated across Europe for his learning after the publication of *Pseudodoxia*, Browne was one of the first writers who used the emerging media as a bridge between scientific research and the general public. He built a reputation as a communicator, praised for his work in fashioning an English vocabulary of scientific discovery, and was much in demand for his learning. After his death a neighbour wrote admiringly: "The horizon of his understanding was much larger than the hemisphere of the world."

Harriet Phillips is a with Queen Mary University of London.

The original article can be found at:
https://theconversation.com/the-man-who-invented-popular-science-used-a-17th-century-version-of-clickbait-71521

News

STEM leaders forge path to stronger Australian science and technology

Presidents, CEOs and other leaders of Australia's most prominent science, technology, engineering and mathematics (STEM) organisations gathered in Canberra on 1 May to highlight the important role that science and technology will play in Australia's future. They released the following statement:

'Collectively representing more than 70,000 Australian scientists and technologists through our membership and staff, we call for science to be a priority platform for the major parties' campaigns in the next federal election.
Science and technology will shape our future, but without adequate support and high profile, Australian science, innovation and discovery will fall by the wayside.

There are four areas of focus we call on decision-makers and candidates to address when Australians are called to vote at the next election:

- A whole-of-government plan for science and technology
- A strategy to equip the future Australian workforce with STEM skills
- Strong investment in both basic and applied research
- Creating policy informed by the best available evidence

Specific issues to be addressed include:

- A thorough and thoughtful response to the R&D Tax Incentive review, that achieves a system that boosts public-private collaboration and accentuates Australia's scientific and technological strengths
- A clear and long-term plan to support Australia's research infrastructure, informed by the National Research Infrastructure Roadmap
- A bold and ambitious national target for scientific and technological research investment, which puts Australia in a position to lead the world in STEM.
- Action to remove barriers (such as caps and limits) that stand in the way of Australians participating and excelling in STEM education

A government that uses science to inform and underpin its decisions will lead Australia to a brighter future.
A government that directly invests in discovery-led, basic research will unlock the solutions of the future.
A government that fosters and rewards innovation and entrepreneurship will secure Australia's economic success.
A government that leads from the front, inspiring the private sector to invest in science and technology, will help Australia achieve a stable and prosperous future.

We, the nation's science and technology leaders, will work hard to ensure that the health, wealth and wellbeing of all Australians are secured for many generations to come.
Working in the solutions sector, the thousands of STEM professionals in Australia will work to tackle the great challenges facing the world, and solve them with science.
In striving towards this bold vision, we ask for the support of Australians, Australian governments and candidates in future federal elections.'

Product News

Dilase 3D by Kloé

The UV-KUB is equipped with UV source based on LED. The LED technology enables the benefits of a perfectly monochromatic source therefore inducing an exposure under cold UVs. No warm up period means LED's allow a continuous or pulsed exposure mode and subsequently, are highly energy-efficient meaning excellent compactness is achieved.

The Dilase range is equipped with state-of-the-art laser source technology, optical treatment lines and motorized stages. Three writing modes are possible: raster scan mode, vectorial mode and the combination of both without compromising the final rendering. Dilase equipment has an unprecedented very large depth of focus compatible with photoinscription over very thick layers (several hundred microns) with high aspect ratio (up to 1x40).

Negative tone and greyscale photoresists are also offered by Kloé. Based on hybrid organo-mineral materials, these resins have strong optical properties and are also biocompatible.

Tangor by Amplitude SYSTEMS

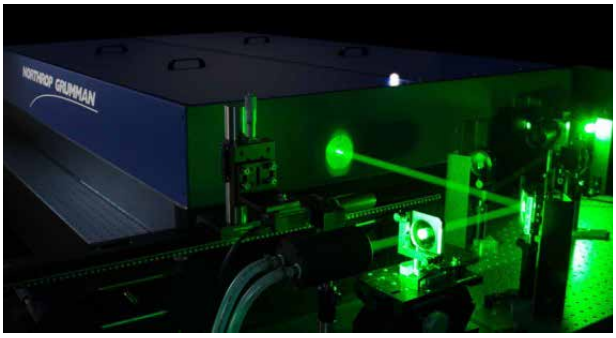
The Tangor is the world's first industrial 100 W femtosecond laser. This platform offers exceptional flexibility, high repletion rates and high pulse energies. Designed to meet both industrial and scientific requirements including 24/7 operation, with high yield and precision output.

The Tangor provides the shortest pulse duration in its class, giving rise to superior processing quality. Unique features of this new generation of ultrafast lasers: (1) Excellence in design, (2) High average power, (3) Burst Mode and (4) Optional green or UV output.

For the most demanding applications, ultrafast lasers offer unmatched benefits. They can process virtually any material without any heat dissipation, and therefore with an extremely high accuracy and quality. Suggested as suitable for scientific uses and manufacturing in micromachining, microelectronics and medical device development and manufacture.

For more information please contact Raymax at info@raymax.com.au or 02 9979 7646

4 Joule DPSS Ti:Sapphire Pump Laser



A new generation of diode-pumped solid-state lasers has been developed that enables ultra-stable Ti:Sapphire pumping at high energies. We report an injection-seeded, all diode-pumped high-energy Nd:YLF laser system based on a master oscillator power amplifier (MOPA) configuration. The laser produces pulses with over 4 J of pulse energy at 10 Hz, 527 nm, and pulse duration of ~13 ns. The laser is specifically designed to produce a uniform, flat-top beam in the near field.

More information: cuttingedgeoptronics.com.

10mJ - 50mJ DPSS PIV Laser Systems

Cutting Edge Optronics manufactures a robust and reliable DPSS PIV laser platform that is designed for efficient installation and integration. Operating under a wide range of pulse energies and repetition rates, the platform meets or exceeds many current requirements established by educational and research PIV applications. This flexibility offers the end user the ability to select the proper laser to visualise flow dynamics with excellent output beams that are temporally and spatially uniform and stable. Each laser's optimised beam profile generates homogenous far field light sheets that offer nearly identical shot-to-shot illumination.

See: www.cuttingedgeoptronics.com

For more information, contact LightOptronics Aust. at rons@lightoptronics.com.au or 08 8327 1885

Cobolt 08-NLD 405nm narrow linewidth laser for Raman Spectroscopy

Cobolt AB, part of HÜBNER Photonics, introduces the Cobolt 08-NLD 405 nm frequency stabilised, Narrow linewidth Laser Diode with up to 30 mW and including an integrated optical isolator. With totally integrated electronics, the compact Cobolt 08-NLD 405 nm is ideally suited for high end Raman spectroscopy or other analytical measurements.

Also available in the 08-01 Series is the Cobolt 08-DPL 532 nm (diode pumped laser), either with or without an optical isolator, Cobolt 08-DPL 561 nm and the Cobolt 08-NLD 785 nm. The Cobolt 08-DPL 532 nm and 561 nm are truly SLM with excellent spectral purity and wavelength stability while the Cobolt 08-NLD 785 nm is a narrow linewidth laser with up to 500 mW.

Red-Wave-NIRX-SR Extended range NIR spectrometer

StellarNet's high performance RED-Wave-NIRX-SR Spectrometers cover the NIR wavelength range from 900-2300 nm in one unit.

The spectrometers are exceptionally robust with no moving parts and are packaged in small rugged metal enclosure (100 x 152 x 70 mm) for portable, processes, and lab applications. The InGaAs detector is a Sensors Unlimited linear photo diode array with 512 pixels (1024 optional) 25µm by 250µm tall to provide best signal performance. The detector has an integrated two-stage thermo electric cooler (TEC) maintained at –20 °C, stabilised within +/-0.1°C. The RED-Wave-NIRX-SR-InGaAs spectrometers use single strand SMA 905 fibre optic input.

Applications include chemical absorption, moisture analysis, transmission of filter and optical components and high power radiometric measurements such as laser characterisation.

Laser diode mount with integrated heatsink

Wavelength Electronics has recently released the LDMOUNT laser diode mount designed for 14-pin butterfly laser diodes that require up to 5A. With built-in safety features and easy connection to a range of different high performance Wavelength Electronics controllers the LDMOUNT can be used in a variety of applications.

Features and benefits:

- Capable of running lasers up to 5A
- Compatible with 14-pin butterfly laser diode packages
- Type 1 and Type 2 butterfly packages are supported
- Zero insertion force (ZIF) sockets holds laser diode
- Laser interlock safety circuit
- Mounts to an optical table
- Compactible with multiple temperature controllers and laser drivers

For more information, contact Warsash Scientific at sales@warsash.com.au or 02 9319 0122

Introducing Kymera 328i – Superior Intelligent Spectrograph

Andor Technology Ltd has released the new Kymera 328i imaging spectrograph. This highly modular spectrograph features patented Adaptive Focus, quadruple on-axis grating turret and TruRes™ technology delivering superb spectral resolution performance.

The intelligent, motorised Adaptive Focus of the Kymera allows automated access to the best optical performance for any grating, camera or wavelength range configuration. The TruRes™ option delivers unmatched spectral resolution for the third-metre focal length spectrograph.

The Kymera 328i sets a new standard when it comes to configurability, being the only imaging spectrograph on the market to offer dual output ports, dual input ports and indexed quadruple grating turret. This provides a unique range of light coupling and spectral performance options to best match current and future setup requirements.

For further information please contact Coherent Scientific at sales@coherent.com.au or 08 8150 5200

New all-in-One detector from Gentec!

This new line of All-in-One detectors combine a detector and a meter with Bluetooth connectivity in one convenient product. The small but powerful meter of the BLU Series presents a Bluetooth connection so you can display the results on your mobile device with the Gentec-EO BLU app available for both iOS and Android systems. Need to use it with a PC? Simply plug in the included Bluetooth receptor and be ready to make power or energy measurements within seconds!

- This new line of All-in-One detectors combine a detector and a meter with Bluetooth connectivity in one convenient product. No need to carry a meter!
- Safer work environment - Operators can be far from the detector while making measurements (up to 30m, depending on the environment and barriers). And with less cables in the workspace, accidents are less likely to happen!
- Receive data at up to 30m from the detector, with the same performance as the usual detector + monitor combination.
- The USB-rechargeable Li-ion battery lasts up to 5 continuous days with the device running
- Go wireless! No need to worry about cable length or monitor location
- Save 50% on calibration costs One Product = One Calibration. Reduce your re-calibration costs by half!

Toptica TeraSpeed Superfast Terahertz Screening Platform

The Toptica TeraSpeed serves applications in quality control and process monitoring that require no spectral information, but call for terahertz intensity measurements at "extreme" speeds: the system is capable of detecting individual terahertz pulses at repetition rates as high as 100 MHz. An integrated data-processing unit converts the detected pulses to RMS values, enabling data streams at sampling rates up to 500 kHz – orders of magnitude faster than conventional terahertz systems. Bringing together several cutting-edge technologies, the TeraSpeed takes advantage of mature fibre laser technology, powerful photoconductive emitters and fast yet sensitive Schottky receivers.

Key Features:

- Extremely fast measurements of terahertz pulse intensities (patent pending)
- Photoconductive terahertz emitter + high-bandwidth Schottky receiver
- Digital output: Data rates up to 500 kS/s, "snapshot" and "continuous" measurement modes
- Analog output: Detection of individual terahertz pulses @ 100 MHz repetition rate
- Robust setup without any delay stages or mechanically sensitive components

Raptor launches NEW Ninox 1280 – VIS-SWIR imaging in HD

Raptor Photonics, a global leader in the design and manufacture of high performance digital cameras has launched an additional member to its family of Visible SWIR cameras with the Ninox 1280, offering HD resolution for high end scientific and astronomy applications.

Using a 1280 x 1024 InGaAs sensor, cooled to -15°C, the Ninox 1280 offers visible extension from 0.4µm to 1.7µm to enable high sensitivity imaging. The 10µm x 10µm pixel pitch enables the highest resolution imaging. It will offer less than 40 electrons readout noise combined with one of the lowest dark current readings on the market. The camera will offer ultra-high intrascene dynamic range of 69dB enabling simultaneous capture of bright & dark portions of a scene.

Available with a 12-bit CameraLink output, the Ninox 1280 will run up to 60Hz. The camera will feature On-board Automated Gain Control (AGC) which will enable the best contrast image from low light to bright as well as an on-board intelligent 3 point Non-Uniform Correction (NUC) algorithm providing the highest quality images. The camera comes with a range of analysis software including XCAP and Micromanager and a standard CameraLink frame grabber (EPIX).

Key Features:
Cooled HD VIS-SWIR technology

- VIS-SWIR technology – Enables high sensitivity imaging from 0.4µm to 1.7µm
- HD Format (1280 x 1024) – The best resolution available in VIS-SWIR
- 10µm x 10µm pixel pitch – Enables highest resolution VIS-SWIR image
- < 40 electrons readout noise – Enables highest VIS-SWIR detection limit
- Air-cooled to -15°C – Enables low dark current for longer exposures
- Ultra high intrascene dynamic range – 69dB – Enables simultaneous capture of bright & dark portions of a scene
- On-board Automated Gain Control (AGC) – Enables clear video in all light conditions
- On-board intelligent 3 point NUC – Enables highest quality images

LIGHT CONVERSION

Excellence in Ultrafast

PHAROS

Fully Automated Femtosecond Lasers for Industry and Science

- *Direct diode pumped, reliable, low cost of ownership*
- *Low quantum defect, 1030nm based on Yb:KGW*
- *1kHz to 1MHz pulse rate*
- *190fs to 10ps pulse duration*
- *Up to 20W, 24/7 in industrial applications*
- *Up to fifth harmonic: 515, 343, 257, 206 nm*

ORPHEUS

Fully Automated Tunable OPAs and NOPAs

- *190nm to 16micron*
- *Down to 10fs*

Attoscience
Few Cycle | CEP | OPCPA

Micromachining
Transparent Materials | Polymers | Metals

Ultrafast Spectroscopy
Transient Absorption | Up-conversion | TCSPC

Sales and Service by

sales@lastek.com.au | www.lastek.com.au

Lastek
Photonics Technology Solutions

Thebarton Campus, University of Adelaide, 10 Reid Street, Thebarton SA 5031 Australia | Phone: 08 8443 8668 Fax: 08 8443 8427

Fractals for Unexplored Areas of Photonics and Energy Storage

by Litty V Thekkekara

Litty was the winner of the 2017 Warsash Science Communication prize with a shorter article based on this work. Here she explores in more detail fractals and how they can be used in photonics and energy storage.

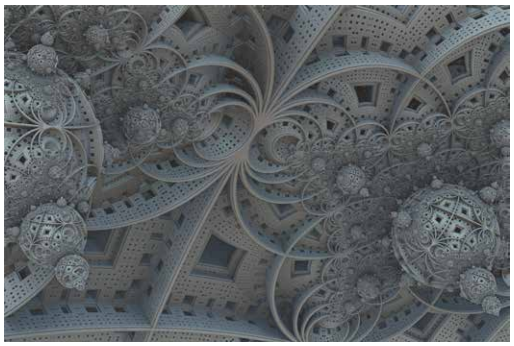


Figure 1. Complex fractal patterns.

Fractals can be seen in natural structures and are a language to describe an iterative self-similar nature. The different families of fractals find applications in various fields such as algorithms, finance, stock markets, musical compositions, human anatomy and astronomy. The ancient civilisations used fractals in their work under the terminology of Chaos from which the branch of science called *Chaology* began.

Fractal mathematics is used to represent complex never-ending chaotic systems such as can be seen in figure 1. Generally, fractal geometry is represented using the "Hausdorff dimensions" which are different from one, two or three-dimensional in normal representations. The somewhere in-between fractal dimension represents the complexity of the patterns. The word fractals was given to these irregular patterns by Mandelbrot in 1971 and is derived from the Latin word *Fractus,* meaning broken or fractured [1].

Fractals in real world applications

Mobile phones, an invention that has had a huge impact on the world can be considered as one of the main examples of fractals in real-world applications. In 1999, Dwight Jaggard and Douglas Werner found that the fractal arrangement of antennas could provide superior transmission of radio signals. Another major illustration of fractals can be found in the algorithm which controls the internet (figure 2). In addition, there is a wide use of fractals in image [2] data compression [3], and data mining [4]. In this article, I will focus on two major areas which have tremendous impact on next generation technologies and the world: neuromorphic photonics and energy harvesting and storage.

Fractals in artificial intelligence (Neuromorphic photonics)

Mimicking the "brain" or so called "mind" as we have seen in science fiction movies to develop artificial intelligence is becoming a reality and a major research topic in recent times. Photonics researchers are not behind in this attempt, giving rise to the field of "*Neuromorphic photonics*". Even though the field is in its early stages, neuromorphic chip based technology has the potential to impact a wide range of areas such as defence, automotive industries, learning, medicine and even space travel.

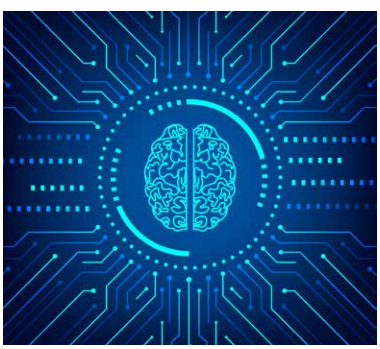
Photonics can influence the journey from human brain to neuromorphic chip; from the fabrication of artificial neural networks, optical transmitters and receivers based on photonic chips for optical signal generation and transfer, photonic memory for information storage and optical detectors for signal detection (figure 3). Furthermore, the development of capsule as well as fibre based endoscopes can be combined with advanced imaging techniques such as super-resolution imaging for better resolution and multifocal imaging for high speed imaging. These techniques can provide the possibility of in situ-imaging of the human brain to collect more information regarding the signal transfer process occurring inside the brain which might be difficult with normal imaging techniques.

The brain is a network of neurons which communicate with each other in the form of chemical signals through synapses. Interconnected neural networks are in general a kind of fractal which belong to the family of a Julia set [5] even though additional fractal families can be considered. Fractal based algorithms for neural computing are widely used by researchers around the world to understand the hierarchy of these complex networks (figure 4) [6]. Hierarchy can apply to the functional properties as well as in the topology and spatio-temporal

Figure 2. Fractal representation of the internet. Image created by Kjpargeter - Freepik.com.

Human brain

Laser fabrication techniques for artificial neuron fabrication
Photonic memory for data storage
Optical transmitters and receivers for optical signal generation and transfer
Optical detectors for detecting the optical signals
Imaging



Neuromorphic chips

Figure 3. Photonics in the transformation of human brain to neuromorphic chips. Images created by Freepik.

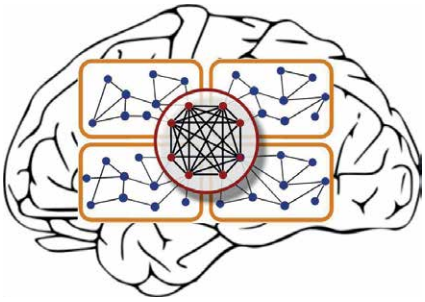


Figure 4. Fractals for hierarchical neural networks. Image taken from [6].

nature.

Fractal designs can be easily integrated into the different areas of neurophotonics mentioned earlier to understand the function, improve the efficiencies of optical devices and to obtain enhanced information storage for next generation artificial intelligence devices.

Fractals in energy harvesting

Fractal designs are widely used in solar cells for solar energy harvesting to maximise light absorption [7]. The intermittent nature of solar energy limits its potential to be used as the primary energy source to replace non-renewable energy resources like coal. Currently, the issue is solved by the employment of expensive energy storage such as batteries with solar modules. But energy storage costs almost 30% of the total cost of solar modules and they have a limited life span, longer charging hours and contribute to environmental pollution.

Moreover, modern technology advancement towards the development of flexible and wearable electronics demands for integrable and portable energy storage. The growth of on-chip laser scribed graphene (LSG) micro-supercapacitors (MSG), which are an integrable category of supercapacitor energy storage [8] and an effective solution [9] to the discussed limitations of energy storage. But the major problem faced by eco-friendly supercapacitors, in general, is their lesser energy storage capacity compared with batteries due to the lower electrode volume accessible for electrolyte ions [10, 11].

We developed a new electrode design concept for LSG electrodes using the internal structure of *sword ferns* which fall into the category of a *self-repeating fractal family* [12] on flexible platforms which resulted in a 30 times increase in the energy density compared to other LSG- MSGs (figure 5) [13]. We extended our studies for integrated solar energy storage using these bioinspired fractal electrodes (BFE) by integrating with thin film amorphous silicon solar cells. The resultant on-chip solar energy storage has a

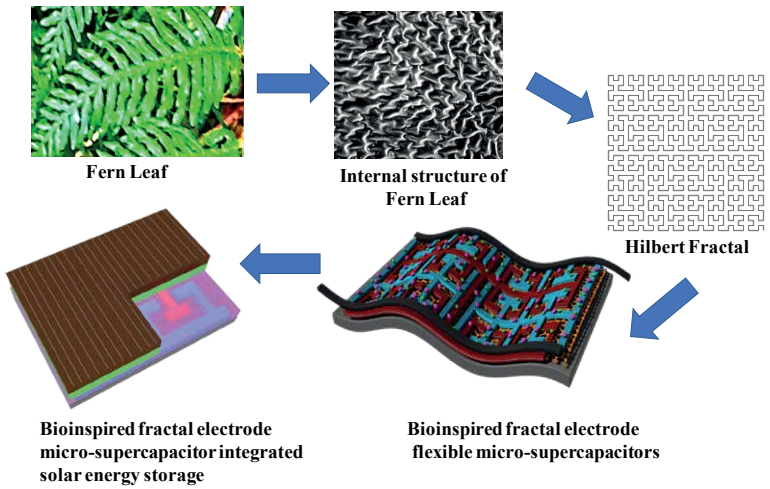


Figure 5. Schematic of transformation of bioinspired fractal energy storage towards on-chip solar energy storage.

95% efficiency without any performance loss of the solar cell (figure 5).

It opens a futuristic platform for self-reliant buildings and flexible applications. The applications of fractals are not limited to these areas, extending to flexible and portable technologies such as micro-electronics and e-skin. The use of these technologies will be fruitful only with the development of large-scale BFE-MSCs for commercial applications. These will come from laboratory research which is an ongoing next phase of the technology in collaboration with industry partners.

References

[1] BB Mandelbrot, *Fractals,* John Wiley & Sons, Inc., 1977.

[2] MF Barnsley and LP Hurd, *Fractal image compression*, AK Peters, Ltd., 1993.

[3] C Traina, EPM Sousa and AJM Traina, *Using fractals in data mining*, New Generation of Data Mining Applications 1 (2005): 599-630.

[4] J Storer, *Data compression*, Computer Science Press, Rockville, Maryland, 1988.

[5] TL Clarke, *Generalization of neural networks to the complex plane*, 1990 IJCNN San Deigo, CA, USA, 1990, 435-440 vol 2.

[6] M Kaiser, CC Hilgetag, and R Kötter, *Hierarchy and dynamics of neural networks*, Frontiers in neuroinformatics 4 (2010).

[7] H Kazerooni and A Khavasi, *Plasmonic fractals: ultrabroadband light trapping in thin film solar cells by a Sierpinski nanocarpet,* Optical and Quantum Electronics 46.6 (2014) 751-757.

[8] BE Conway, *Electrochemical Supercapacitors: Scientific Fundamentals and Technological Applications*, Kluwer Academic/Plenum Publishers (1999).

[9] W Gao et al, *Direct laser writing of micro-supercapacitors on hydrated graphite oxide films*, Nat. Nanotech. **6**, 496–500 (2011).

[10] MF El-Kady and RB Kaner, *Scalable fabrication of high-power graphene micro-supercapacitors for flexible and on-chip energy storage,* Nat. Comm. **4**, 1475 (2013).

[11] LV Thekkekara et al, *On-chip energy storage integrated with solar cells using a laser* scribed graphene oxide film. Appl. Phys. Lett. 107 (3), 03110 (2015).

[12] HJS Smith, *On the integration of discontinuous functions,* Proc. Lond. Math. Soc., Series 1 **6**, 140-153 (1874).

[13] LV Thekkekara and M Gu, *Bioinspired fractal electrodes for solar energy storages,* Sci. Rep. **7**, 45585 (2017).

Litty V Thekkekara is with the School of Science, RMIT University.

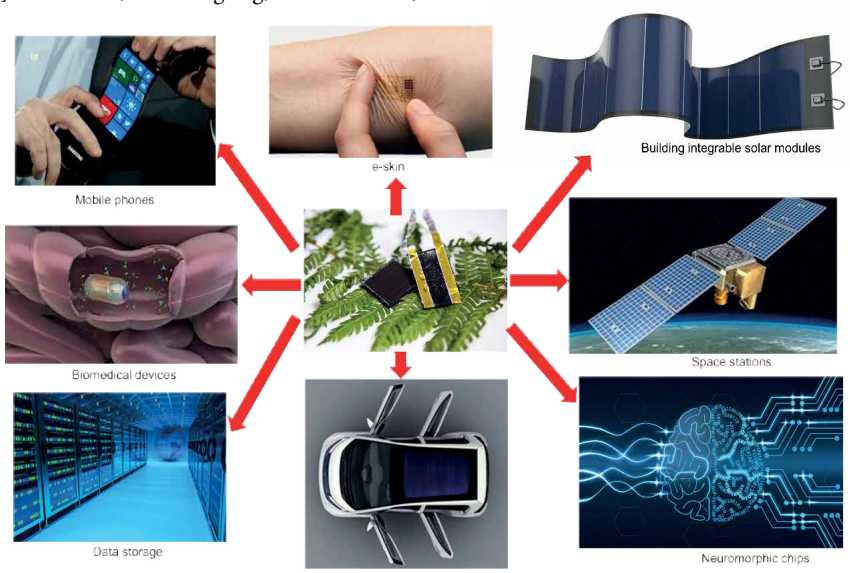
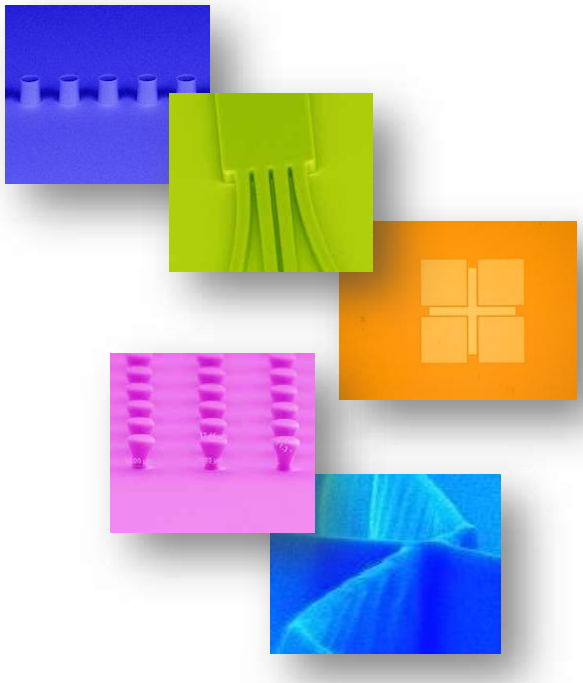


Figure 6. Applications of bioinspired micro-supercapacitors and solar energy storage.

DILASE 3D

Ultramodern photolithography technologies available in a 3D table-top printing system



DILASE 3D offers new achievements in laser photolithography:

- A great depth of focus, special optical processing allows thick layers with the same verticality of edges and minimal roughness
- Work in 3 dimensions with a resolution of 5μm
- Write on all type of substrate such as semi-conductor, glass, polymer, or thin film on a surface expendable up to 100 x 100 mm, and a thickness of 50mm

Dilasesoft and **3DSlicer** is the standard software suite in all models. 3DSlicer allows you to visualize and convert 3D design files for use with the Dilase 3D system

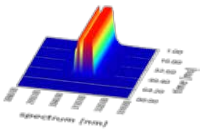
Raymax LASERS

For more information on the Dilase 3D or Kloé systems contact
Raymax Applications Pty Ltd
t: 02 9979 7646 e: info@raymax.com.au

MIRIAD technologies

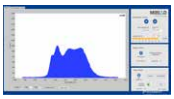
The Miriad S3

The ***Fastest*** mid-IR spectrometer on the market.



Broad wavelength coverage (1 to 5 µm)

Portable design (< 2 kg and USB powered)



1550 nm mode (with resolution < 0.4 nm)

*...all for a price that's more **affordable** than you think!*

Find out more at: www.miriad-tech.com
For a quick quote: sales@miriad.co

Miriad Technologies, 36 Bradfield Road, Lindfield, NSW | sales@miriad.co | Designed and Made in Australia

Optics in Everyday Life: Mirages: Inferior and Superior

by Tony Heyes

If ever you see Melbourne from Rye then it must be a clear day and you must have good eyesight. But, also, something else must be happening ..... Read on .....

Rye is a beach suburb sixty-three kilometres due south of the Central Business District of Melbourne. Between the two there is just water: Port Phillip Bay. Occasionally one can see the Melbourne Central Business District from the Rye foreshore.

This is very odd because you should *only* be able to see the tips of the two tallest buildings in Melbourne. The rest are well over the horizon.

What you would be seeing is something really quite fascinating: an atmospheric phenomenon, refractive looming and possibly a **Superior Mirage**. Let me explain:

Firstly, there is nothing *superior* about a superior mirage. It just means it is up there rather than down here.

We are all familiar with *inferior* mirages. These are the ones that occur on hot days when one sees what, to all intents and purposes, looks like a puddle of water in the road ahead. However, it stays ahead; just like the end of the rainbow, it cannot be reached. The effect is caused by refraction from a temperature gradient in the air near the ground, hence density gradient, hence refractive index gradient. What this means is that the air near the road is hot and therefore has a lower refractive index than the air above. The layers of increasing refractive index refract the image so that the higher, cooler, denser, air causes the image to appear to be reflected at the boundary with the lower, hotter, less dense air.

A *superior mirage* is a rarer event. It requires there to be a **temperature inversion** i.e. just the opposite temperature gradient. This is when the air near the ground is colder than the air above. In the case of Port Phillip Bay it occurs when the water, and hence the adjacent air, is colder than the air above. In this instance the layers of differing refractive index cause the rays of light to be refracted, and sometimes reflected, downwards. Under these conditions one can actually see over the horizon – often by a very long way.

Let us do a simple calculation. Using the easily derived formula for the distance d to the horizon, from a vantage point above the Earth's surface of height **h:**

$\mathbf{d = \sqrt{2hR}}$ where **R** is the radius of the Earth (6.37×10^6 metres), we can calculate that a person of average height standing at the water's edge at Rye beach, will see the horizon at 4.6km away. This is nowhere near the actual distance of 63 km from the city of Melbourne. Yet with the aid of a superior mirage one can, on occasion, see the city looming way past the horizon! For details, see reference 2.

The literature tells us that superior mirages can take the form of towering, looming, and inversion, depending on the particular density structure of the air column.

However, being pedantic - and what scientist isn't - the title Superior Mirage should only be applied to the latter case. That is the case of the inverted image. Mirage is a French word meaning reflected image. Towering and looming involve the refraction of light. The inverted image involves the (internal) reflection of light. Strictly speaking, that alone is the Superior Mirage [3].

There is yet another type of superior mirage, the *fata morgana*: a complex mirage in which distant objects are distorted as well as elongated vertically. For example, a relatively flat shoreline may appear to have tall cliffs, columns, and pedestals. The phenomenon occurs under much the same meteorological conditions as the superior mirage with inversion and contains features of both towering and inversion.

Some well known examples of seeing beyond the horizon are:

- Seeing the Isle of Man from the Lancashire coast. (Seeing this in August 2005 inspired me to write this article).
- Seeing the Norwegian mountains from the top of the Cairngorms in Scotland.
- Seeing the mountains of Greenland from the mountains of Iceland.

Superior Mirages (known as the *hillingar* in Icelandic) are common in

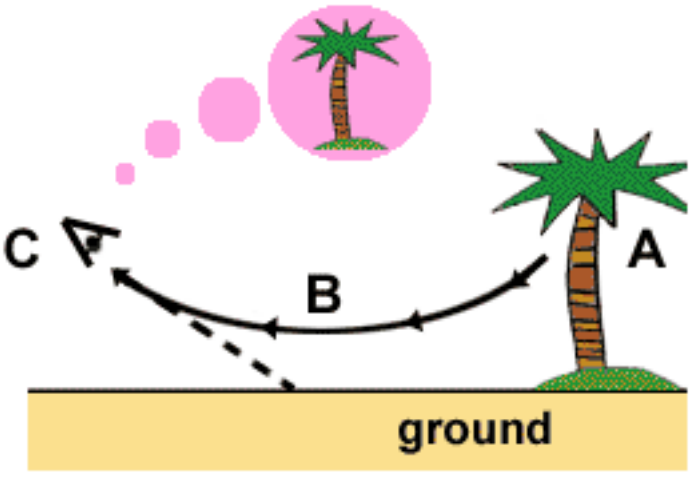


Figure 1. An Inferior Mirage: an image of the palm tree is seen reflected in a pool of light from the sky. Taken from Reference 1.

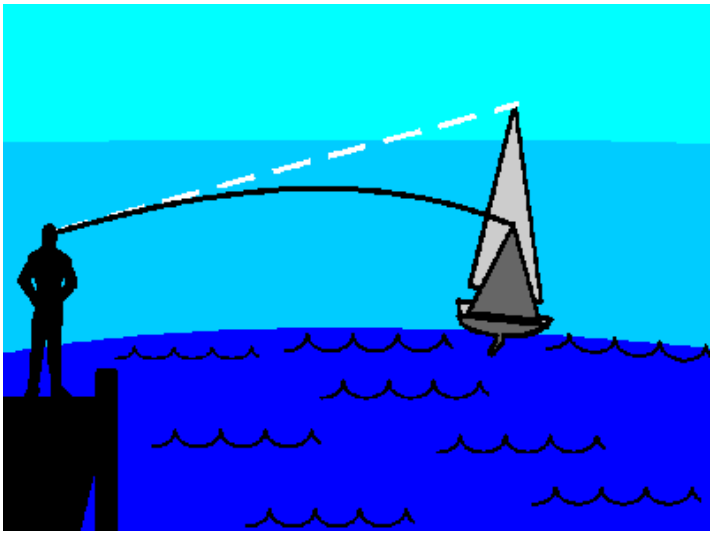


Figure 2. Refractive towering: the image appears to be elongated. Taken from reference 3.

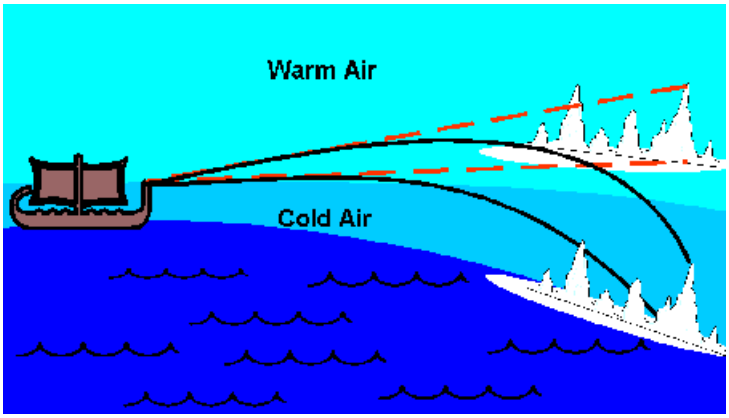


Figure 3. Refractive looming: the Vikings see over the horizon. Taken from reference 3.

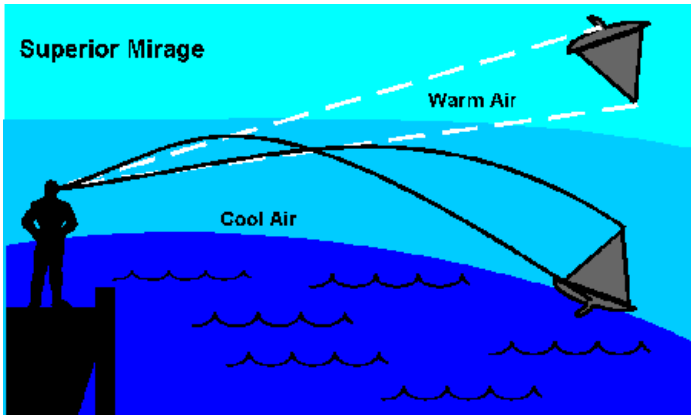


Figure 4. An inverted image: a phantom image in the sky. Taken from reference 3.

the Arctic and the Antarctic. They have played an important role in Arctic and Antarctic exploration. In other parts of the world they are less common. They occur most frequently after dark. Could car headlights seen over the horizon be interpreted as UFOs?

References

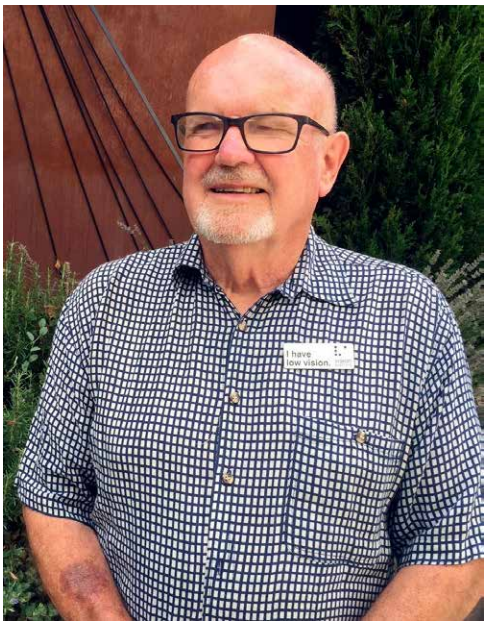
[1] www.hk-phy.org/iq/mirage/mirage_e.html
[2] http://members.optuszoo.com.au aheyes40/pa/Mirage.html
[3] www.islandnet.com/~see/weather/elements/supmrge.htm

Guest Columnist Tony Heyes is an Honorary Fellow in the School of Physics at the University of Melbourne. He is unusual in that he has two doctorates, the first in Physics, obtained at the University of Cambridge, the second in Psychology from the University of Nottingham.

Tony had serious vision problems and spent most of 1966 having eye operations. Fortunately the eighth operation worked and he regained the sight in one eye. This experience led to an interest in developing electronic travel aids for the blind. He worked for 17 years at the Blind Mobility Research Unit in the Department of Psychology at Nottingham. A spin-off from this work is the now ubiquitous Parking Sensor; Tony patented this in 1983.

Tony emigrated to Australia in 1987 to take up a post created for him: Manager Research and Development at the Royal Guide Dogs Association.

A partially sighted bird watcher, Tony claims to see more UFOs in a day than most people see in a lifetime.

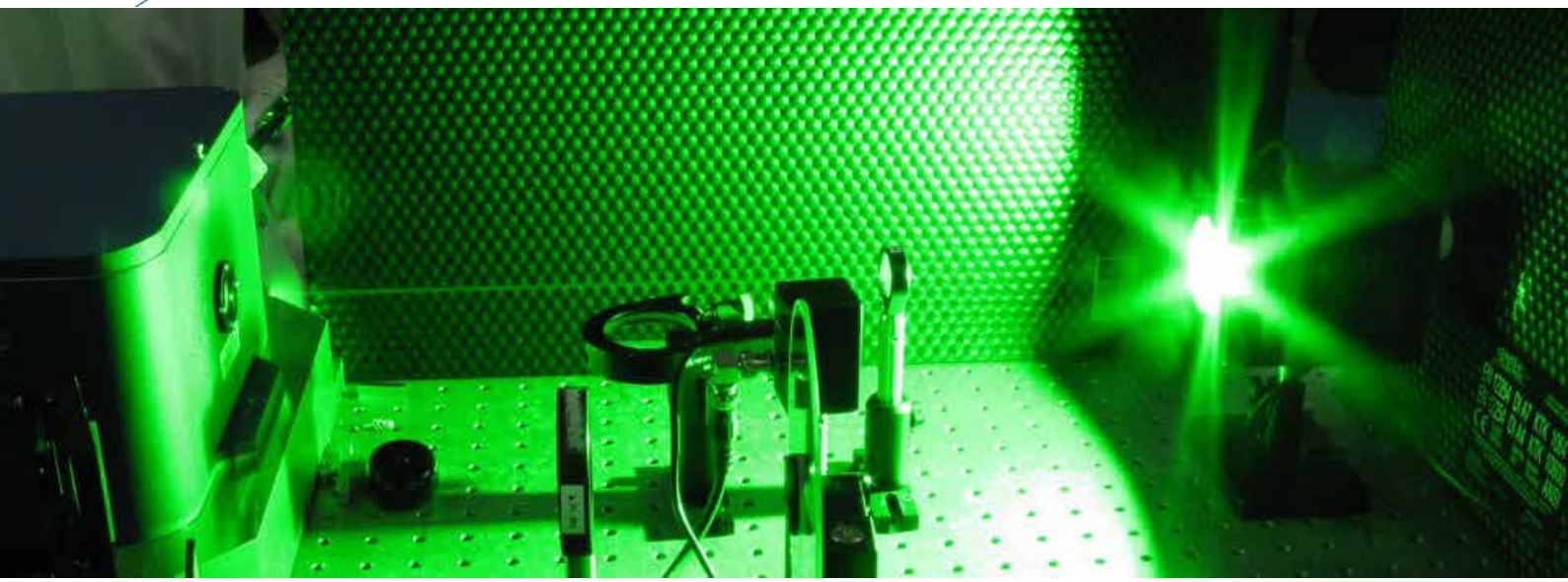


LightOptronics Aust.™

Commercial & Medical Solutions

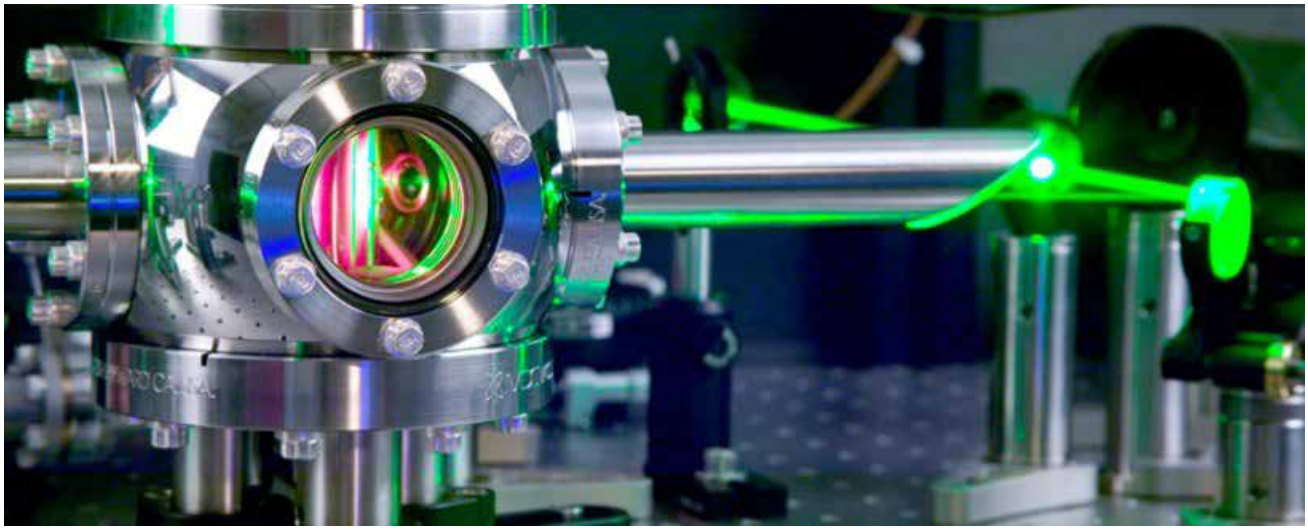
NORTHROP GRUMMAN

Cutting Edge Optronics



Pump Lasers for Ultrafast Amplifiers

* Patara-HP Q-switched green lasers are ideally suited for pumping Ti:sapphire ultrafast amplifiers
* Excellent beam quality combined with stable output
* Variable repetition rates from single shot to 30 kHz, and pulse energies up to 50 mJ



www.lightoptronics.com.au, (08) 8327 1885
rons@lightoptronics.com.au

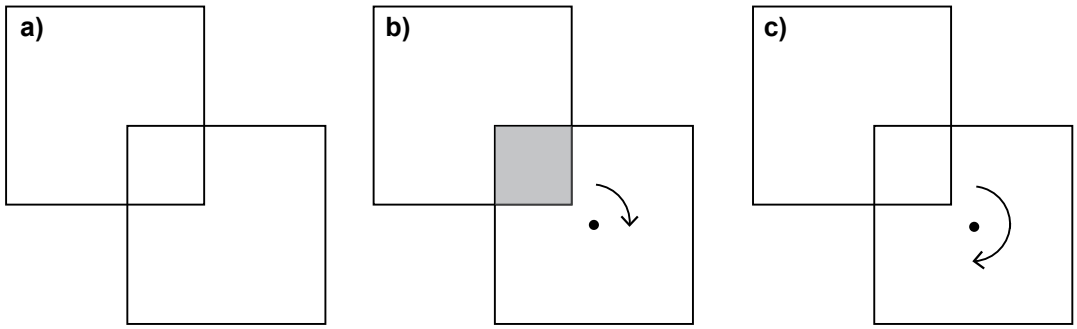
"Super - Polaroid" - A Quiz

by Tony Klein

This quiz concerns a special kind of polarising sheet that I have dubbed "Super Polaroid". Can you figure out how it works? The correct answer will appear in the next issue.

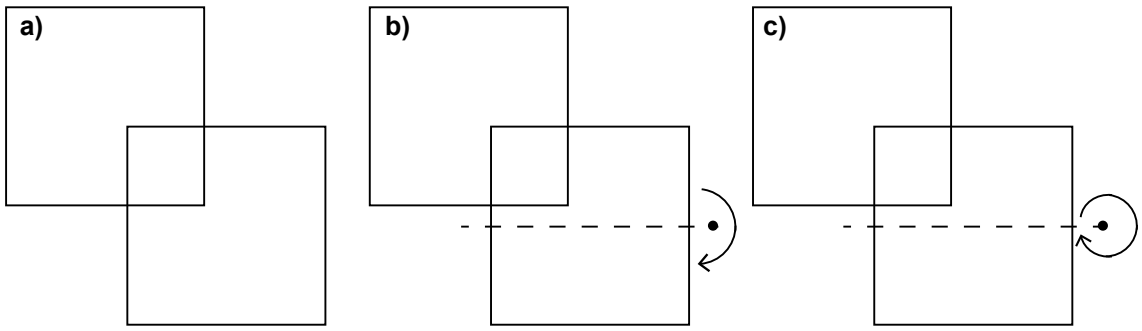
As is well known, **ordinary** polarising plastic sheet (i.e. "Polaroid") behaves in the following way: When two pieces of it are superimposed, the overlapping region is transparent, but when one of the sheets is rotated by **90°** about a **perpendicular axis**, the overlapping region becomes opaque – and clear again if rotated by a further **90°**. This is how polarising sunglasses work, of course (figure 1 a, b, c).

Figure 1



Furthermore, when the top piece is rotated by **180°** about a **horizontal axis** as in figure 2 (a, b, c), the behaviour remains unchanged – the same if the overlapping region starts out opaque: it will remain opaque.

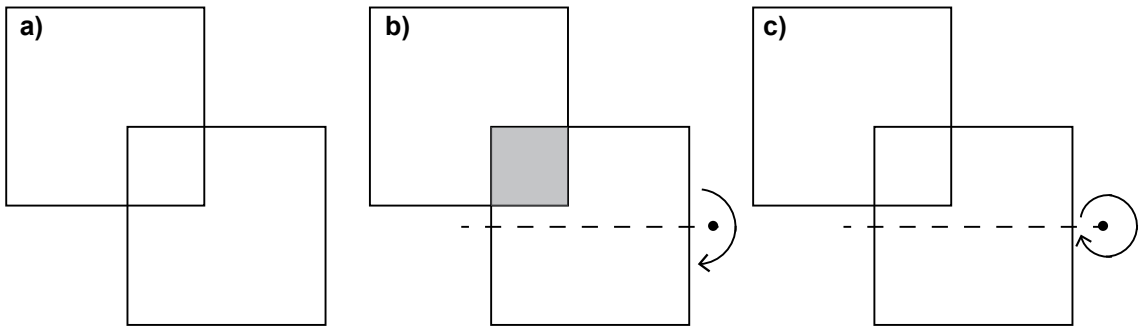
Figure 2



Now consider the behaviour of "Super Polaroid": When the top piece is rotated about the perpendicular axis, i.e. **in plane**, by **90°**, it behaves just like ordinary polaroid, i.e. just as in figure 1 (a, b, c).

However, when rotated by **180°** about a **horizontal axis**, the overlapping region becomes opaque and becomes clear again when rotated by a further **180°** (see figure 3 (a, b, c)).

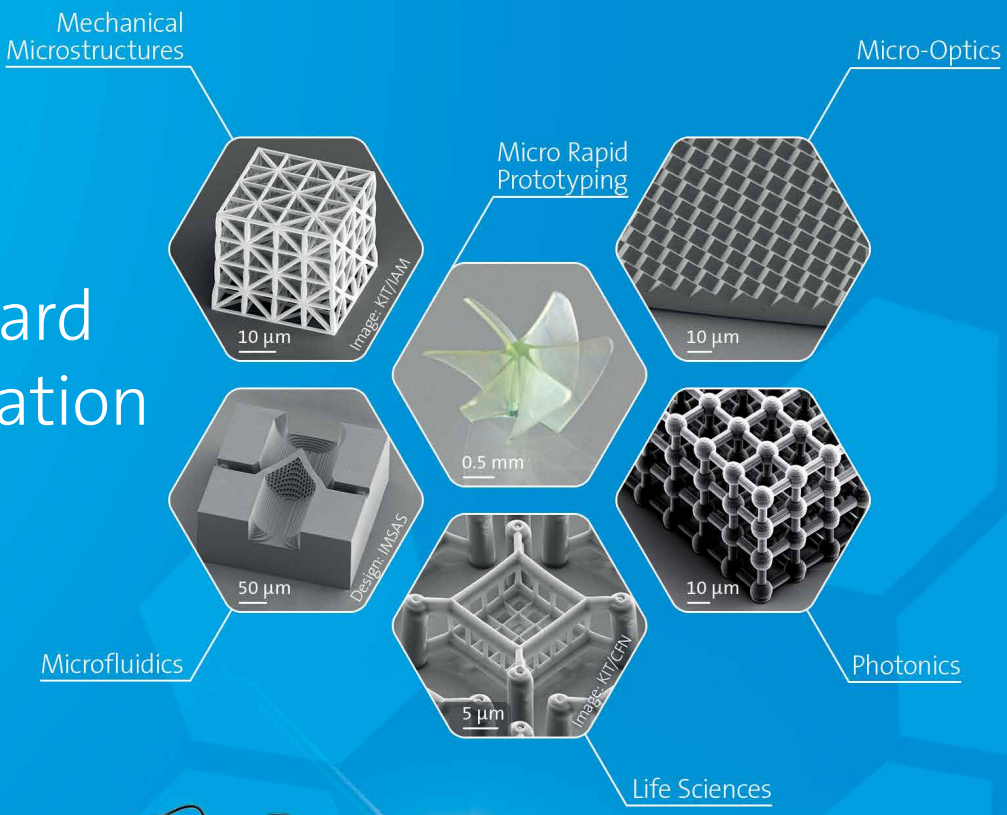
Figure 3



How do you explain this behaviour? What is special about "Super Polaroid"?

Emeritus Professor Tony Klein is with the School of Physics, University of Melbourne.

The New Standard For Microfabrication



PRISM AWARDS WINNER

Photonic Professional GT

The World's Highest Resolution 3D Printer

- Additive manufacturing and maskless lithography in one device
- Versatile solution for the challenges in nano-, micro- and mesoscale fabrication
- Submicrometer feature sizes and resolution with optical quality surfaces
- Diversity of UV-curable print materials with designer characteristics
- Smart and user-friendly integrated software package
- Robust, accurate and easy-to-use system
- Top universities and industry pioneers worldwide use our award-winning 3D printers

nanoscribe
www.nanoscribe.com

Warsash Scientific
Advanced Instruments for Research & Industry

Contact our Australian & New Zealand sales agent Warsash Scientific:
Phone: +61 2 93 19 01 22 | sales@warsash.com.au | www.warsash.com.au

Index of Advertisers

Corporate Member Address List

Coherent Scientific Pty Ltd
116 Sir Donald Bradman Drive
Hilton, SA, 5033
Tel: (08) 8150 5200
Fax: (08) 8352 2020
sales@coherent.com.au
http://www.coherent.com.au

CUDOS
School of Physics,
University of Sydney, NSW, 2006
Tel: (02) 9351 5897
Fax: (02) 9351 7726
martin@physics.usyd.edu.au
http://www.cudos.org

Ezzi Vision Pty Ltd
Vacuum & Thin Film Coating
PO Box 206, Chirnside Park, VIC 3116, Australia
Office: 1 Dalmore Drive, Caribbean Business Park,
Scoresby, VIC 3179, Australia
Tel: +61 (0) 3 97270770
Fax: +61 (0) 3 86101928
adil.adamjee@ezzivision.com.au
www.ezzivision.com.au

Laser SOS Ltd
Unit 3, Burrel Road, St. Ives, Cambs,
PE27 3LE, United Kingdom
Tel: +44 1480 460990
Fax: +44 1480 469978
sales@lasersos.com
http://www.lasersos.com

Lastek Pty Ltd
10 Reid Street
Thebarton, SA, 5031
Tel: (08) 8443 8668
Fax: (08) 8443 8427
sales@lastek.com.au
http://www.lastek.com.au

LightOptronics Aust.
29 Pitcairn Circuit
Seaford Rise, SA, 5169
Tel: (08) 8327 1885
rons@lightoptronics.com.au
www.lightoptronics.com.au

Miriad Technologies Pty Ltd
36 Bradfield Road
Linfield NSW 2070
Tel: +61 415 942 644
sales@miriad.com
http://www.miriad-tech.com/

Raymax Lasers Pty Ltd
PO Box 958,
Newport Beach, NSW, 2106
Tel: (02) 9979 7646
Fax: (02) 9979 8207
sales@raymax.com.au
http://www.raymax.com.au

Warsash Scientific Pty Ltd
PO Box 1685, Strawberry Hills
NSW, 2012
Tel: (02) 9319 0122
Fax: (02) 9318 2192
sales@warsash.com.au
http://www.warsash.com.au

23RD AUSTRALIAN INSTITUTE OF PHYSICS CONGRESS

Joint with

Australian Optical Society (AOS) Conference; 43rd Australian Conference on Optical Fibre Technology (ACOFT); 2018 Conference on Optoelectronic and Microelectronic Materials and Devices (COMMAD 2018)

9-13 December 2018 Perth, Western Australia

Abstract submission closes 15 June

aip2018.org.au

Invitation to a magnificent week of world-class science

The Australian Institute of Physics and the Australian Optical Society, with the support of the Australian National Fabrication Facility (ANFF) and the Australian Nanotechnology Network (ANN), warmly welcome you to the 23rd AIP Congress and the Australian Optical Society Conference that will be held jointly with the 43rd Australian Conference on Optical Fibre Technology (ACOFT) and with the 2018 Conference on Optoelectronic and Microelectronic Materials and Devices (COMMAD). Seamlessly integrated to form one of Australia's foremost science forums, the meeting will take place in beautiful Perth on the leafy campus of the University of Western Australia, during 9-13 December 2018.

To Australia's industries, we welcome your presence at the congress and look forward to your suggestions as to how to make the Congress most relevant to you! To Australia's science teachers, we want to include you as part of the Congress and look forward to your involvement. To all university academics, government and industry scientists, to all science students and to our international colleagues, please help us make this a big success by submitting your best work to this conference.The conference strongly supports the principles of equity and diversity and encourages contributions from all. The Congress organisers will strive to achieve gender balance and are committed to equal representation of male and female speakers in plenary and invited talks.

On behalf of the Australian physics, science and technology community, welcome to Perth!

Gerd Schröder-Turk (Chair of Organising Committee), Jodie Bradby (Vice-President Australian Institute of Physics), Simon Fleming (President Australian Optical Society)

Earlybird registration closes 10 June

Postdeadline papers close 15 July

THE HONG KONG POLYTECHNIC UNIVERSITY 香港理工大學

OSA The Optical Society

IEEE Photonics Society

COS THE CHINESE OPTICAL SOCIETY

EIC Electronics Society

The Australian Optical Society

OSK OPTICAL SOCIETY OF KOREA

The Japan Society of Applied Physics

KPS

IEICE Communications Society

ANDOR

an Oxford Instruments company

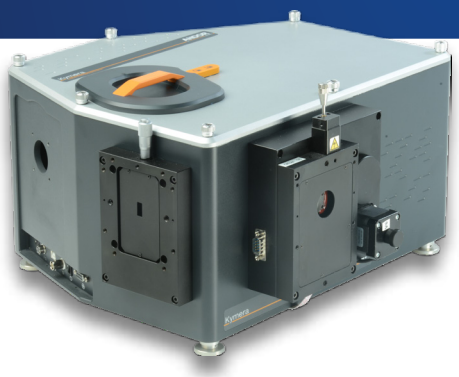
Modular Spectroscopy

CCD, EMCCD, ICCD, InGaAs, Spectrographs

- Ultra-sensitive CCD and EMCCD detectors
- ICCD detectors for time-resolved studies
- InGaAs detectors with 1.7µm and 2.2µm response
- Full range of spectrographs
- Accessories for coupling to fibres, microscopes, Thorlabs cage systems

Raman
Absorbance
Plasma
Microspectroscopy
Hyperspectral imaging
CARS
Photoluminescence
Nanoparticles
Single Molecule
Fluorescence
LIBS
Combustion

NEW



Kymera 328i Intelligent and Highly Modular Spectrograph

Adaptive focus technology
TruRes – Improved spectral resolution
Quad-grating turret with eXpressID
Dual inputs and outputs for maximum flexibility

Read more in the Product News section inside

(08) 8150 5200
sales@coherent.com.au
www.coherent.com.au

Coherent SCIENTIFIC