International Year of Light illuminates Paris

The International Year of Light is well underway: the official opening ceremony was held at UNESCO headquarters in Paris on 19 and 20 January.

CUDOS Director, Professor Benjamin Eggleton, attended the event and gives this account of ceremony and the significance of International Year of Light for the photonics community.

The opening ceremony for the International Year of Light was a two-day celebration of the wonderful and diverse ways in which human society is uplifted by our interaction with light. The ceremony was most aptly held at the UNESCO headquarters in Paris, a city known for centuries as The City of Light.

UNESCO itself was founded in the aftermath of World War Two as an organization designed to build lasting world peace by encouraging humankind to work in solidarity towards a common future where democracy, development and human dignity are available to all. UNESCO strives to achieve this goal by promoting education as a human right, fostering intercultural understanding, pursuing scientific cooperation and protecting freedom of expression.

In line with UNESCO’s goals, the organizers put together an event that celebrated the scientific, economic and social impacts of how light is used, offering a fascinating overview of the way a seemingly small innovation in one area can have profound impact in the lives of many. Over the two days we heard from a range of people who have made light the focus of their life’s work.

Presentations ranged from Nobel Prize winners explaining how our understanding of light informs our understanding of the foundations of the cosmos, to grassroots workers showing how bringing eyeglasses to isolated African villages or light into the homes of the poorest slum dwellers can fundamentally change human lives for the better. It was a rare and wonderful opportunity for all of us to lift our focus from the specifics of our own work and see the way that science interconnects with human societies around the globe.

Over the year there will be a host of activities, festivals and events across Australia to celebrate importance of light in our daily lives. CUDOS, a gold sponsor of International Year of Light, has organised a year-long series of events and will be focusing on developing its International Outreach resources for teaching photonics science to schools students. The inventor of the quantum cascade laser, Harvard University’s Professor Frederico Capasso, was at the University of Sydney on 17 March for CUDOS’s first International Year of Light event, the Peter Domachuk Memorial Lecture.

“This diversity in the presentations gave rise to stimulating conversations about the intersection of physics, technology, development and society. The International Year of Light asks us to expand our intellectual horizons when we consider the impact of our work.”

- Professor Ben Eggleton
Head of School Report

Welcome to another issue of Physics News. It is fitting to see several stories related to the International Year of Light, which has relevance to almost everyone doing research in the School of Physics.

As usual, we have many things to celebrate. Congratulations to Michael Seo, PhD student supervised by Professor Kostya Ostrikov, for winning the best presentation prize at the AIP NSW Postgraduate Awards Day for his talk on Single Step, Plasma Enabled Transformation of Natural Precursors into Graphenes and their Applications in Energy Storage Devices. Congratulations also to Dr Daniel Huber (DECRA Fellow in SIfA), on being awarded the NASA Exceptional Scientific Achievement Medal for his research on the properties of stars found by the Kepler Mission to host extra-solar planets.

Professor Marcela Bilek was named an Institute of Electrical and Electronics Engineers Fellow, in recognition of her contributions to the science and application of plasma processes for materials modification and synthesis. Professor Anne Green was elected to The Australian Academy of Technological Sciences and Engineering, whose aim is to enhance Australia’s prosperity through technological innovation.

I would also like note that the School of Physics was recently awarded a Bronze level Pleiades Award for demonstrating a commitment to a range of initiatives that will promote awareness of unconscious bias, encourage full participation of women at all levels of professional life, and recognize the importance of work-life balance. This award acknowledges the ongoing efforts of our Physics Equity and Access Committee, about which you can read more page 10.

In the past few months we have said farewell to two long-serving members of our technical staff. Win Myo has retired after 29 years service to the University, and is well known to generations of students and staff after working in the First Year teaching labs for the past 23 years. Phil Dennis (Senior Technical Officer), has retired after 35 years in the School. We offer our thanks and best wishes to both. In addition, Honorary Associate Professor Ian Johnston has ended his long teaching career at the University. Ian was first appointed to an academic position in the School in 1965 and continued to teach after his retirement. He will continue his research work in Physics Education at the School.

Finally, as you can read in this issue, Dick and Penny Hunstead have shown extraordinary generosity with a gift of $1.4 million to establish the Dick Hunstead Fund for Astrophysics. The fund will be used to support research activities in the Sydney Institute for Astronomy (SIfA). We are enormously grateful to Dick and Penny for this gift, which will benefit staff and students for generations to come.
School of Physics sheds light on Astronomy and Photonics at VIVID Ideas 2015

As part of International Year of Light 2015, the University of Sydney is taking part in the VIVID Festival with a public event hosted by Adam Spencer in the Great Hall on 28 May 2015.

Aimed at high-school students, teachers and science enthusiasts, the event will feature six speakers delivering ten-minute presentations in the style of TED talks, followed by hands-on displays in the Quadrangle.

Speakers from a variety of disciplines (physics, biology, engineering and design) will cover a range of topics focused on different aspects of light, from design and illumination to light in robotics and remote sensing. Dr Tara Murphy and Dr Darren Hudson represent the School of Physics in the lecture series.

In her talk entitled Light: Revealing the Hidden Universe, Dr Murphy will describe how astronomers look beyond light to fully understand the Universe. “When we look up into the night sky, everything we can see is visible because it emits or reflects light. The invention of telescopes revolutionised our understanding of the Universe, capturing faint light that has travelled through space from distant galaxies. For centuries light has been our primary tool for exploring space. However, in modern astronomy, we need look beyond light, to the extreme ends of the electromagnetic spectrum, to fully understand the Universe we live in,” Dr Murphy explains.

Dr Murphy will discuss some of the hot topics that University of Sydney astronomers are working on: how we use radio waves and gamma-rays to reveal the moment when black holes form; how we can use clever techniques to reveal otherwise invisible planets in distant solar systems; and how we can map the evolution of galaxies through cosmic time.

In a second talk Dr Hudson, a DECRA fellow working with CUDOS, will be presenting research aimed at delivering major societal impact through the application of lasers and photonics. Recent advances made at the University of Sydney and the Australian National University have opened the door for laser light to be used for non-invasive analysis of human breath, and for improved laser surgery. Dr Hudson will cover the development of the world’s first ultrashort-pulse mid-IR fibre laser, created at the University of Sydney, and a new photonic chip that can produce light covering a large portion of the infrared spectrum and brighter than light from a synchrotron. These first-of-their-kind laser systems will enable breakthrough applications for 21st century photonics.

For further information contact Ms Liz Kenna at liz.kenna@sydney.edu.au.
Upcoming events

Public events

SPARC International Lighting Event
27 to 29 May 2015 at Sydney Exhibition Centre Glebe Island
Visit sparcevent.org

The Revolution in Radio Astronomy by Professor Elaine M Sadler
The Science & Research Breakfast Seminar Series 2015
26 August 2015 at NSW Trade & Investment Centre, MLC Centre, 19 Martin Place
Registration via maryse.delorie@business.nsw.gov.au

Conferences

WOMBAT: Workshop on Optomechanics and Brillouin Scattering: Fundamentals, Applications and Technology
20 to 22 July 2015, Sydney
Visit www.cudos.org.au/wombat

Quantum Astronomy and Stellar Imaging 2015: Celebrating the 50th birthday of the Narrabri Stellar Intensity Interferometer
17 to 19 August at Darlington Centre, University of Sydney
Visit www.quantumastro2015.org

Astronomical Data Analysis Software and Systems (ADASS) Conference
25 to 30 October 2015 at Rydges World Square
Visit www.caastro.org/event/2015-adass

SPIE Micro+Nano Materials, Devices, and Systems Conference
6 to 9 December 2015 in the new Australian Institute of Nanoscience, University of Sydney
More information at spie.org/x27167.xml
Inventor of the Quantum Cascade Laser lectures at Sydney

Professor Federico Capasso took his audience on a wide spanning journey from the application of his invention, the quantum cascade laser* (QCL), at a public talk on the 17th of March 2015.

The Harvard University Professor detailed how the QCL has been widely used in surveillance, healthcare and environmental monitoring to recent scientific advances in structured light that could revolutionise the 'Internet of Things' and smart wearable optics such as Google glasses. His talk also touched on his recent design of a completely flat optical lens, a groundbreaking invention with many commercial possibilities.

The flat optics has major potential in areas like imaging, photography and displays, by allowing replacement of standard lenses with ultrathin flat ones.

"These ultracompact lenses have the advantage of creating images without the distortions (known as aberrations) of conventional optics.

The correction of these aberrations such as the fact the different rays and different colors are focused in different points, blurring images, requires bulky and expensive objectives made of multiple lenses,” he explained.

"Flat lenses can be fabricated on the facet of optical fibers opening the door to exciting biomedical applications such as new stethoscopes and fabricated on essentially any type of substrates including flexible materials."

Professor Capasso was speaking at this year’s Dr Peter Domachuk Memorial Lecture series, established to honour and commemorate University of Sydney graduate, Dr Peter Domachuk’s outstanding contribution to optical physics and biophotonics research. It was also the School of Physics’ first International Year of Light 2015 event.

AIN Update

2015 is both the International Year of Light and the year that permanent power was connected to the AIN building (i.e., the lights now work).

Additional light comes into the building from the sky because of the AIN building’s all glass facade and skylights. These provide both sunlight and views for the teaching areas, for the offices and meeting rooms and for the breakout areas. Nearly the opposite is true for many of the laboratories, where the environment must be strictly controlled and sealed off from the external world and where in some instances, e.g. laser labs, daylight must be totally excluded.

The control and interaction of light is not a new requirement for physics. Indeed, in the heritage-listed Physics building, the long axis of the building was designed to enable certain classes of optical experiments to be conducted in the corridors. On the exterior of the building, the north-facing ‘sills’ housed siderostats to reflect sunlight into rooms for spectrographic work.
Sydney astrophotonics SAILs on

The Sydney Astrophotonic Instrumentation Laboratory (SAIL) based at the School of Physics will open its doors in late 2015. SAIL will be the new astrophotonics and astronomical instrumentation laboratory under the Sydney Institute for Astronomy (SIfA) and the Institute of Photonics and Optical Science (IPOS) at the School of Physics.

“It is timely that the SAIL launch will coincide with the International Year of Light and Light-based Technologies (IYL 2015) endorsed by UNESCO; this is a very exciting opportunity indeed. As the foundation of our new astronomical photonics instrumentation capabilities, SAIL will attract a high calibre of students and will provide an invaluable training resource for the School of Physics and the University as a whole”, says Dr Sergio Leon-Saval, SAIL Director.

SAIL will be formed by new refurbished laboratories at the School of Physics and an investment of almost $2m dollars by the University of Sydney in new equipment and facilities. These laboratories will turn photonics innovations and research into state-of-the-art instrumentation and next-generation devices. SAIL will be a core resource within the School of Physics, used by students and researchers to develop prototypes of photonics instrumentation. This flexibility will enable cross-disciplinary academic teams to be co-located, enabling a more dynamic research environment. The new laboratory will facilitate common open area of research and training not only for the Faculty of Science but also for other USyd Engineering research centres.

“In SAIL we will have a facility in the School of Physics that enables us to develop and translate outstanding research in astrophotonics and astronomical instrumentation into real world outcomes for society and fellow researchers,” says Professor Joss Bland-Hawthorn, Laureate Fellow and SIfA Director.

SAIL research will be aimed at advancing the limits of knowledge in photonics instrumentation, and it will give scope to some of the University’s most valuable people: our students and early-career researchers. Central to SAIL’s mission is the training of the next generation of scientists and engineers, through access to cutting-edge experimental infrastructure and mentoring by researchers that are among the world’s best in their field. This training will equip talented students and early-career researchers with unique capabilities that help them become future leaders, in either the academic world or industry.

Meanwhile the Physics building is about to receive some much-needed attention. The external facade is currently being painted and the windows cleaned and repaired. Later in the year there will be modifications to the large south-facing arched window in the main foyer, which will provide a line of sight and an entrance through to the AIN.

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$1.4 million gift celebrates an astronomer’s life at the University

“We are morning and evening sky watchers. We live right on the sea front and see the most superb skies with all the constellations. We have wonderful views of the moon over the sea and every sunrise,” says Penny Hunstead.

Penny and Dick Hunstead met on Newport Beach. They still live there and have been watching its changing skies together for over 47 years. That’s when Dick, also known as Professor Richard Hunstead of the University of Sydney, is not sky-watching professionally.

For nearly 50 years, just slightly longer than his marriage, Professor Hunstead has been researching astronomy and teaching physics to students at the university.

“I was lucky to join the university just at the time radio astronomy was an up-and-coming science, one which offered a different way of viewing the cosmos. It was a thrill during my PhD to work with the Mills Cross radio telescope, then one of the newest instruments to change the face of the discipline.”

Professor Hunstead went on to make several important discoveries and has published over 200 articles, with quasars, black holes, and the formation and evolution of galaxies just some of his areas of interest.

For his contribution and dedication, especially to his students, Penny Hunstead decided that any money they gave to the university should be in Dick’s name.

The $1.4-million Dick Hunstead Fund for Astrophysics will support the Sydney Institute for Astronomy (SIfA). The Institute, based in the School of Physics, is one of the most diverse astrophysics groups within Australia, spanning optical, radio, infrared, X-ray, theoretical and computational astrophysics.

“We’d previously given small amounts of $500 or $1000 to the university, but this was a chance to give this crucial institute the support it deserves. The money will help current students and encourage more to take up study in this area,” said Professor Hunstead.

There has been a substantial growth in astrophysics internationally, driven largely by the developments of new observational facilities. SIfA’s most valuable instrument is the Molonglo Observatory Synthesis Telescope, a forerunner of the international Square Kilometre Array project.

“It is crucial that the institute positions itself to make the most of opportunities. As part of lifting its profile I want prominent astronomers such as Martin Rees, Emeritus Professor of Cosmology and Astrophysics at Cambridge, to visit.”

Whenever Dick takes students out to Siding Spring Observatory they are transfixed, astronomers and non-astronomers alike, by the beauty of its night sky.

“That wonder and fascination is what I still feel for astronomy. The field is on the cusp of a new era of discoveries across the whole electromagnetic spectrum. But of course the most exciting discoveries are the ones we cannot yet name or even imagine.”

Dick and Penny share many interests, including a love of native plants (Penny is a trained botanist) and have a shared life-long commitment to philanthropy, including volunteering.

A favourite saying of Penny’s is one of Mahatma Gandhi’s: “The best way to find yourself is to lose yourself in the service of others.”

This gift celebrates Professor Hunstead’s service to the University and the couple’s shared philosophy as embodied in Gandhi’s quote.
Young Cambodians coding their way to future careers

They may not own computers or know how to blog or tweet yet, but learning computer programming may help many Cambodian children find their way into future careers.

Dr Murphy and her colleague, Associate Professor James Curran from the Faculty of Engineering and Information Technologies are working with the Cambodian Children's Trust (CCT) to help make that a reality.

The academics are adapting their tailored program, the National Computer Science School Challenge, which currently teaches Australian teenagers the necessary computing skills to analyse science.

CCT emphasises using local people to make its programs both culturally appropriate and, ultimately, self-sufficient. Local teachers and interpreters are already involved in this project.

"We've just completed a pilot program in Cambodia with Year 10 students, primary-school children and their teachers. Most of them have no computer training and many of them don't have a computer so we were very impressed with how well they picked up the concepts and logical thinking needed to complete courses using programming languages," said Dr Murphy.

"It gave us the insights and confidence to adapt our program for a full-year curriculum that will be taught this year to high-school students and adapted for primary-school students."

The partnership came about when Tara Winkler, Director of the CCT, approached Dr Murphy. Ms Winkler established the organisation in Battambang in northwest Cambodia in 2007, to educate and support Cambodian children.

Among Ms Winkler's achievements, recognised with the NSW Young Australian of the Year award in 2011, is training young people to run a financially independent restaurant and art gallery in Cambodia.

"We are honoured to have the support of the University of Sydney to launch CCT's STEM education program. After seeing the success of the initial trial, I am so excited about the potential for this project to open doors and create life-changing opportunities for Cambodia's youth," said Ms Winkler.

The Australian enterprise software company Atlassian is also supporting the program, by funding a teacher.

The ultimate aim of the project is to create a computer lab that the trained computer programmers could operate from as freelancers.

"We are starting small but aiming high," Dr Murphy said.
By inviting a guest scientist to interact with students via Skype, Crook is able to raise the profile and learning of science in primary schools.

In early March 2015, Professor Geraint Lewis of the Sydney Institute for Astronomy (SIfA) joined a Skype session with Year 5 and 6 class at St Ambrose Primary School, Concord West. The students compiled a long list of questions regarding travelling to Mars (the unit they were studying) plus astrophysics in general. The questions included: “how many women study astrophysics?”, “can a black hole suck in another black hole?” and “are there parallel universes?” Professor Lewis answered with aplomb with the students (and teachers) hanging on his every word.

Some of the extensive feedback included “I found the Q & A today very intriguing. I really enjoyed discussing black holes and learning about galactic cannibalism” (Hannah, aged 10).

The students, parents and the school were over the moon to have an experienced scientist Skype into class. Crook and Professor Lewis are keen to repeat this at more schools, especially in the southwest of Sydney. Anyone else interested can contact simon@simoncrook.com.

Science on Skype

Sydney University Physics Education Research (SUPER) PhD candidate and CrookED Science founder Simon Crook has launched a new project where scientists speak to students about the wonders of science and explain their fields of expertise.
What is Physics Equity and Access Committee (PEAC)?

PEAC is a group of staff and students in the School who are exploring ways to ensure the School is a fair and welcoming workplace for all students and staff, regardless of gender, race, religion, sexual orientation or disability. In doing so, it hopes to increase the diversity of the School so that it better reflects the population and makes it better able to attract and support talent from every part of the community. All members of PEAC volunteered for the role and members include students, academic and professional staff, men and women.

What has PEAC done?
PEAC is still in its early stages but has already begun a series of initiatives. These include:
- Running a survey of staff and students
- Collating statistics about the numbers of men and women in different stages in their physics career and historical trends
- Providing a website with information and links to support services, policies and PEAC news
  sydney.edu.au/science/physics/about/equity.shtml
- Providing a more diverse range of career profiles in the School publicity material
  sydney.edu.au/science/physics/about/profiles.shtml
- Providing a confidential reporting system for any problems or concerns
- Appointing and training equity officers within the school to help identify and resolve problems

PEAC is also pleased to support the offer of a prestigious Messel Fellowship for a leading female post doctoral fellow. This fellowship will be advertised and assessed in parallel with the University Fellowship Scheme.

As a result of these efforts, the School of Physics was awarded an inaugural Bronze Pleiades Award. The Pleiades Awards recognise organisations in Australian astronomy that take active steps to advance the careers of women through focused programs and strive for sustained improvement in providing opportunities for women to achieve positions of seniority, influence and recognition.

This is just a start. We will keep you up to date about our progress in subsequent issues of Physics News, including our analysis of statistical trends in the School.

How can you help?
We are always looking for alumni stories that reflect the diversity of people, career choices and experiences. We also interested in ideas that you may have, particularly to increase opportunities for women in physics. In the next issue, we will also be asking you to participate in an alumni survey to better understand the career experiences you have had both at the School and subsequently.
Physics’s Home Brew

For this edition of Physics Newsletter, we are featuring Scott Brownless and Alexander Judge, two-thirds of Ångstrom Brewing.

One takes beer more seriously when physicists start brewing them. It all started at the School of Physics.

“At the start of my PhD, I met Chad (Husko, also from CUDOS) who was working as a postdoctoral researcher at the time. He had been a long time homebrewer and needed some brew buddies in Australia. Chad came from New York, where the craft beer scene has gone wild, and saw that Australia was heading that way too, so after spending a couple of years of perfecting our recipes, we decided to turn pro,” shares Scott who completed an Undergraduate Advanced Science Degree, Honours in Photonic Crystal Waveguide Arrays with CUDOS and is now doing his PhD in Optical Metamaterials.

Alex, on the other hand, started a degree in Medical Science at the University of Sydney. After his first year, he realised he was better at physics and mathematics than biology. He transferred to the School of Physics, which became his home, on and off, for 18 years. He completed his PhD in Theoretical Astrophysics and worked as a Postdoctoral researcher at CUDOS. This is where he met Scott and Chad. “I first home brewed in my undergrad days so when Scott and Chad, good friends and colleagues of mine, fired up Angstrom it was a great opportunity to rekindle a hobby and make it professional.”

When asked about why they got into brewing – “There’s a lot tinkering with different things that happens in the School of Physics, and if you look at the number of people in the Physics building that homebrew...it’s pretty high!” says Alex. “The analysis, problem solving, and general rational thinking skills you acquire while studying physics, are widely applicable to many endeavours,” he adds.

Scott also shares some applications of optics to brewing. “Although Beer’s Law is a standard concept in optics, there isn’t a huge amount of optics that goes into our beers. Brewers use refractometry to determine the beer’s density, then to derive its alcohol content. In larger commercial labs, microscopy can be used to determine yeast viability and absorption spectroscopy has been used at times to determine the chemical makeup of different beers,” he explains.

Of brewing and learning
Scott and Alex both attest to their enjoyable experience studying at the University of Sydney. The University’s great reputation for physics research, opportunities to collaborate with colleagues such as the third year special projects, outstanding lecturers, and wide variety of extracurricular activities all contributed to their life on campus. “Between the mostly wonderful lecturers and many friendships I formed along the way, it was a hugely stimulating and fun experience,” Alex says.

When asked how the rigor of training as a physicist helped in running Angstrom Brewery, Scott says, “The biggest lessons applied from my studies are how to perform rigorous testing of a parameter space, and controlling for variables when creating new recipes.”

Scott was a member of the Board of Directors for the University of Sydney Union for two years, where he learnt some valuable lessons about the inner workings of an organisation. This proved to be extremely useful in setting up their business.

Angstrom Brew beers are available at the Dove and Olive, Keg and Brew Hotel in Surry Hills; The Union and Kingston Public Bar in Newtown; Little Guy on Glebe Point Road; Forest Lodge Hotel; Empire Hotel in Annadale. In the city: Spooning Goats on York Street, Harts at The Rocks; The Bitter Phew on Oxford Dalringhurst; and Quarrymans Hotel in Pyrmont.
Blue Dress Illusion

It’s a very rare occasion when visual neuroscience and textile technology combine to take over the Interwebs, but in February 2015 the famous Blue Dress did it.

So what’s going on? It’s a six-part answer – with five definite Do-Knows, and one Don’t-Know.

First, the dress is actually blue. Photoshop lets you analyse individual pixels. It tells you the dress is blue. See the photo above.

Second, the eye is easily fooled when perceiving colour. It’s good at comparing, but not good at working out absolute values. For example, the same chess piece can look black or white, depending on its background colour.

Third, the eye-brain combination tries really hard to maintain what the visual neuroscientists call ‘colour constancy’. Consider a white sheet of paper. It just reflects the colour of the ambient light. It will be white in bright sunlight, but under the red lights of a nightclub it will be red.

But this change of colour bothers your brain. So your brain has evolved colour constancy, where it ‘adjusts’ or compensates for the ambient light, removes the reddish influence of the nightclub lights, and suddenly the sheet of paper looks white – even though it’s reflecting red light and actually looks red.

Colour constancy is a survival advantage. A red apple always looks the same colour, whether that particular food item is in the shade, or in sunlight.

Fourth, the photo of the now-famous blue dress is, purely by accident, beautifully ambiguous. There is no bare skin – which would give you a good idea as to the dress’s true colour.

All you get is the fabric of the blue dress – and an out-of-focus band of background brightness on the right side of the photo. This might make you think that the front of the blue dress is in shadow.

But, at the top of the dress is a panel of shiny fabric that is partly reflective. This is essential for helping to create this optical illusion. Visual neuroscientists call these mirror-like reflections on the shiny part of an object ‘specularities’. Specularities can give you the best clue as to the colour of the ambient light. In this case, the specularities give you the impression that the dress was well-illuminated from the front.

Fifth, we can now put it all together.

If you assume that the front of the dress is in shadow (thanks to the bright blurry background light), your brain will apply colour constancy and remove the blueish hue of the shadow – and bingo, the dress is white.

But if you assume that the front of the dress is well lit (thanks to the shiny reflections on the top panel of the dress), you will see the dress as blue.

So that’s what we know.

And finally for item six – which is what we don’t know.

Why do some people assume shadow and a white dress, while others assume brightness and a blue dress? We don’t know. As far as we know, it’s not related to your emotional state of mind, or your emotional or intellectual intelligence.

As in all visual illusions, we’ve been blinded by the light ...

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