Possum, flash and askap

What has the International Year of Astronomy meant to astronomers at the School of Physics' Sydney Institute for Astronomy? Dr Phil Dooley reports

"I'm exhausted!" says Professor Bryan Gaensler. "There have been so many public talks and events." It's nearing the end of 2009, the International Year of Astronomy (IYA), and as one of Australia's foremost astronomers, he's been run off his feet.

As well as giving talks Professor Gaensler has been involved in some unique events staged in honour of the IYA. He was the host when *Around the World in 80 Telescopes* – an international live web streaming event – crossed to the School of Physics' radio telescope at their Molonglo field station, just outside Canberra.

"I think *Around the World in 80 Telescopes* was really successful," he says. "Tens of thousands of people from all over the world logged onto the website to see a different telescope every 20 minutes. People really got the idea that astronomy is more than just peering through an eyepiece."

Professor Gaensler was also a star of *Music and the Cosmos*, along with two colleagues, Professors Tim Bedding and Geraint Lewis, which packed more than 600 people into the Great Hall to hear the three speak, interspersed with the Conservatorium of Music's Brass Ensemble playing selections from Holst's *The Planets*. Afterwards the crowd spilled into the Quadrangle to telescopes and experiments set up by students from the School of Physics. The public's enthusiasm for astronomy is clear from the popularity of *Music and the Cosmos* – it was fully booked six weeks before the event, and many were turned away – but what gets the professional astronomers excited?

"A burst of gamma rays from the oldest thing ever detected," says Professor Gaensler. Detected by the NASA Swift telescope, the radiation had been travelling for 13 billion years (thereby making it the furthest thing ever seen as well). "The burst of gamma rays is thought to be caused by a very early star dying and forming a black hole, but we weren't even sure if stars had formed that early in the universe. It's like seeing a bunyip."

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Another 2009 "world-record" detection thrilled Professor Anne Green, astronomer and Head of School of Physics: "The first direct observation of a planet orbiting another star." Although nearly 400 planets of other stars have already been detected by indirect means, a photograph from the Hubble space telescope showed a direct image of a planet orbiting the star Fomalhaut, even though the planet was a million times fainter than its parent star.

Planets in other solar systems – exoplanets – have captured astronomers' curiosity. In 2009 the Kepler spacecraft, designed specifically to search for planets circling other stars, was launched. Professor Tim Bedding is working on the Kepler project, measuring the oscillations of stars. "We have some amazing data," he says. "There will be some exciting results published in January." (The *Astrophysical Journal Letters* is publishing a special issue with results from the Kepler project.)

It's not only the Kepler project that has astronomers on the edge of their seats. "We're waiting for quite a few machines to come on line," says Professor Joss Bland-Hawthorn. His research highlight of the year was successful testing of a new instrument named GNOSIS, designed to detect faint infra-red radiation from stars. "The atmosphere glows at you in the infra-red, even at night," he says. "But GNOSIS will make the night sky 100 times darker." Results should start to flow in 2010.

Professor Bland-Hawthorn's work is another highlight for the Head of School, Professor Anne Green. "Joss's photonic lanterns, if they come off, will make spectrographs that are currently the size of a whole room the size of a matchbox."

Closest to Professor Green's heart, however, are the radio astronomy endeavours within Sydney Institute for Astronomy (SIfA). As Australia bids to build the largest array of telescopes on the planet – the Square Kilometre Array (SKA) – two prototype instruments are being built to trial technologies for it. Professor Green is the director of the SKAMP project, the Square Kilometre Array Molonglo Prototype, located at the School of Physics' Molonglo Field Station. With new optical fibre data feeds and digital signal processing, SKAMP will be an enormously fast and powerful instrument; first results are expected in 2010.

Another forerunner of the SKA is ASKAP (the Australian Square Kilometre Array Pathfinder), an array of 36, 12-metre radio telescopes being built by a consortium of 19 countries in remote Western Australia, on the proposed site for the SKA. As well as being 10 times more powerful than current telescopes, ASKAP will have an extremely wide field of view, with its 30 square degree field giving a "fish-eye" view of the sky.

"It will be able to survey the whole sky in an hour," says Professor Gaensler. "It'll be mind blowing." He is the principal investigator of one of the 10 initial projects selected to run when ASKAP comes online in 2013. Two of his neighbours in SIfA, Professor Elaine Sadler and Dr Tara Murphy, are also principal investigators on ASKAP projects. "It shows the strength of our radio astronomers," says Professor Gaensler. "Within two metres we have the leaders of one third of the projects on the world's most powerful telescope."

Professor Gaensler's survey is named POSSUM (POlarisation Sky Survey of the Universe's Magnetism) and will investigate the magnetic fields that permeate the solar system, the galaxy and the nearby universe. The trick to measuring the magnetism of distant objects is through the effect magnetic fields have on radio waves as they pass through the field; if the radio waves happen to be polarised, then the direction of polarisation will rotate. Finding polarised sources in the sky is not common, however, this is where the wide field and sensitivity of ASKAP will come into its own. Professor Gaensler estimates they will be able to increase the number of known polarised sources to more than three million, an increase of one hundred fold. "Understanding the universe is impossible without understanding magnetic fields," he says. "We will dramatically improve our understanding of astrophysical magnetic fields."

Next door to Professor Gaensler is Professor Elaine Sadler, the principal investigator on ASKAP's First Large Absorption Survey in neutral Hydrogen (FLASH). Her 2009 highlight was finishing a five-year high-frequency survey of the southern sky with the Australia Telescope Compact Array radio telescope at Narrabri. "We found a big population of young radio sources, which pinpoint the recent activity of black holes in distant galaxies. Something triggers them, and then they grow and die over 100 million years. It's kind of the ecology of galaxies."

Having finished one big survey, she's already planning another; this time for ASKAP. Like Professor Gaensler, Professor Sadler is searching for material that's everywhere, but hard to detect. "Neutral hydrogen is the major component of the universe, but you can only see it through its weak emission of radio waves at wavelength 21cm." she says. "Because it's so weak we can only see nearby hydrogen gas clouds. Beyond that it's as if there is a brick wall. We hope to push that brick wall back a long way."

Across the corridor, Dr Tara Murphy's project for ASKAP, Variables And Slow Transients (VAST), takes quite a different angle. As the title suggests, Dr Murphy is looking for flashes and pulses in the distant sky.

"All sorts, flare stars, supernovae, solar magnetars, gamma ray bursts," she says. "But the problem is that to see these varying sources, you need to go back and observe the same patch of sky again and again to detect the changes, and you have to balance that with surveying a wide area."

Dr Murphy, whose position is a joint appointment between the School of Physics and the School of IT, is also relishing the technical challenge of processing the volume of data that will be produced by ASKAP.

"We'll be getting gigabytes of data per second, we won't even be able to store it all," she says. "It's a new paradigm. We'll have to have algorithms to do everything faster and better on the fly, and throw away the data we don't want and never see it again. For some of the older astronomers it's extremely horrific!"

Not all the "older astronomers" are horrified. Professor Dick Hunstead, Director of SIfA in the School of Physics, is involved with Dr Murphy's VAST project, and agrees that data will have to be sacrificed.

"It's a practical reality," he says. "Just the way of the world. Astronomy moves with the times, and it's a different sort of scene, where people are doing big surveys and not focusing on individual objects so much. But with the internet, the data's still there in the public domain, with undergrads or even amateurs getting access to it, and picking out things the professionals have missed. It makes it a little bit more exciting, and keeps us on our toes." **SAM**

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