THE UNIVERSITY OF SYDNEY

SCIENCE ALLIANCE NEWSLETTER

DNA ANALYSIS OF A HORSERACING LEGEND

BY VERITY LEATHERDALE

A new chapter in the story of Phar Lap is about to be added by the University of Sydney as it leads an attempt to sequence the famous horse's DNA.

Lead researcher Dr Natasha Hamilton: "We are doing this out of scientific curiosity and all our data will be made publicly available.

"Phar Lap's heart is in Canberra, his hide is in Melbourne, and his skeleton in the Museum of New Zealand Te Papa Tongarewa. Now the museum has agreed to a 60mg piece of tooth from that skeleton coming to Sydney so we can unravel his genetic history," said Dr Natasha Hamilton, the team leader from the University's Faculty of Veterinary Science. Professor Claire Wade, also from the faculty, will be in charge of the genetic analysis.

The DNA extraction will be performed at the Australian Centre for Ancient DNA (ACAD), at the University of Adelaide, before being analysed at the University of Sydney.

"We are doing this out of scientific curiosity and all our data will be made publicly available. The DNA sequence will tell us if Phar Lap's genetic make-up looks like star racehorses of today, including whether he is a sprinter or a stayer (genetically better suited to running long distances)," Dr Hamilton said.

"We believe that no other southern hemisphere racehorses have had their whole genome sequenced before. By contrast, in Europe this research is quite popular and DNA analysis has been performed on notable horses such as Eclipse, racing's first superstar and an ancestor of 95 percent of today's thoroughbreds, and Hyperion, a popular sire from the 1930-50s who is found in numerous pedigrees."

The information will be used in current Faculty of Veterinary Science research such as international studies to understand the basis of genetic diversity in different breeds of horses, the structure of the thoroughbred breed and the genetics underlying the physiology of exercise across all horse species.

The skeleton was treated by being boiled in a corrosive solution which will have fragmented the DNA.

"There is a possibility that we will not be able to get much usable DNA, as they were obviously not thinking about the possibility of future DNA extraction when they prepared Phar Lap's skeleton in the 1930s," said Professor Alan Cooper, ACAD Director.

Professor Claire Wade said that despite this limitation current whole genome sequencing methods can work with small pieces of DNA, so the researchers are hopeful they will be able to generate usable information.

The fragmentation of the DNA also means it would not be usable in other projects that require large amounts of good quality DNA such as cloning.

"So, sorry punters, there is no hope of Phar Lap II running around a few years from now," Dr Hamilton said.

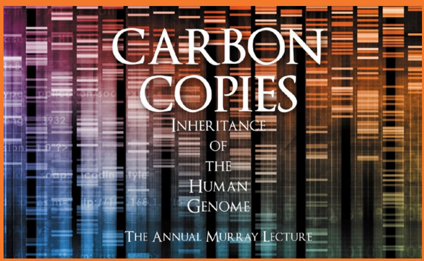
This is not Phar Lap's first association with the University of Sydney. According to research quoted by Museum Victoria the horse was named by Aubrey Ping, a medical student at the University in the 1920s.

EVENTS:

SYDNEY SCIENCE FORUMS

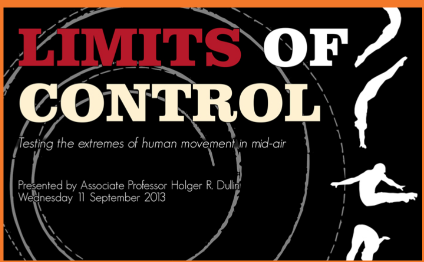
CARBON COPIES: INHERITANCE OF THE HUMAN GENOME

Wednesday 21 August 5:45-6:45pm
Eastern Avenue Auditorium



LIMITS OF CONTROL: TESTING THE EXTREMES OF HUMAN MOVEMENT IN MID-AIR

Wednesday 11 September, 5:45-6:45pm
Eastern Avenue Auditorium



THE FAST AND THE FAR-REACHING: ADVANCES IN QUANTUM MECHANICS

Wednesday 16 October, 5:45-6:45pm
Eastern Avenue Auditorium

For more information and to register visit:
sydney.edu.au/science/outreach/forum

SYDNEY UNI OPEN DAY

31 AUGUST, 9AM-4PM
Camperdown Campus

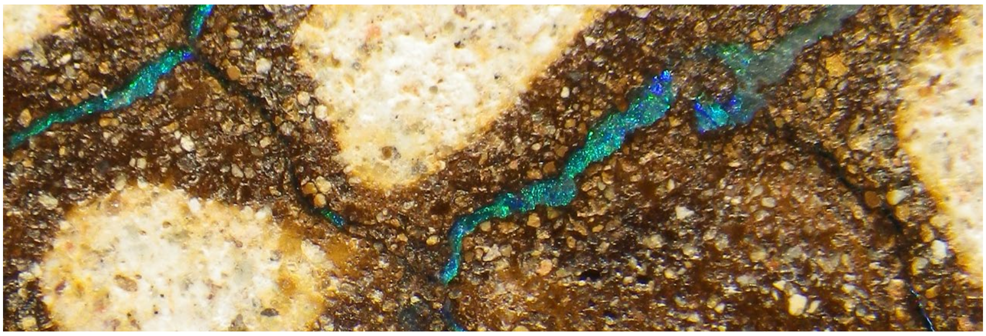
Open Day is the chance for anyone thinking about studying at Sydney to come on campus, speak to the academics, look around, go to a few lectures, and much much more.

For more information
sydney.edu.au/open_day

ANSWER TO OPAL MYSTERY SHOWS RED CENTRE'S LINKS TO RED PLANET

BYVERITY LEATHERDALE

The dramatic geological events that created opal, Australia's national gemstone, have been described for the first time by a University of Sydney researcher.



Precious opal veinlets in a sandstone from central Australia.

The explanation underlines how the geology of Australia's Red Centre is the most similar on Earth to the geology of Mars, to the extent it could yield valuable information on that planet for a fraction of the cost of a space mission.

"Australia produces over 90 percent of the world's supply of opal. Before this we did not know its origin, why it forms at such shallow depths or why it can be found in central Australia and almost nowhere else on Earth," said Associate Professor Patrice Rey, from the University's School of Geosciences.

His findings have recently been published in the Australian Journal of Earth Sciences.

"The formation of Australian opal was due to an extraordinary episode of acidic weathering, during the drying out of the central Australian landscape," said Associate Professor Rey.

This occurred when the Eromanga sea, a vast body of water covering 60 percent of Australia, extending from Coober Pedy to the Carpentaria Basin and across to Lightning Ridge, started retreating.

Between 100 million and 97 million years ago this sea came to cover a much smaller area. This meant the previously inundated central Australian landscape started drying out and acidic weathering happened on a massive scale when pyrite minerals released sulphuric acid.

Acidic weathering of the type that took place in Central Australia is unique on Earth at that scale, covering an estimated 1.3 million km2, but it has been described at the surface of Mars.

"The USA and the European community have invested billions of dollars to send orbiters and rovers to Mars in the hope of finding extra-terrestrial life but Central Australia offers a unique natural laboratory where potential Martian bio-geological processes could be studied."

Notably, opaline silica, iron oxides and clay minerals similar to those found in central Australia were discovered at the surface of Mars in 2008, where they were interpreted as the product of acid weathering of volcanic debris covering the red planet.

"Many Australians familiar with the unmistakable features of Australia's Red Centre may not realise, despite their similarly striking red appearance, that it shares many of its remarkable characteristics with Mars, which also appears to be why opaline silica forms there."

To create the precious opal found in Australia, as opposed to opaline silica, demands a switch to alkaline conditions before silica-rich gel trapped in fractures and cavities dehydrates and solidifies. This is only possible when the host rock, as in Australia, has a large acid-neutralising capacity.

The opal discovery is personally satisfying for Associate Professor Rey who first encountered Australia as a schoolboy in France, through a 1970s documentary on opal mining in Coober Pedy. Thirty years later the Lightning Ridge Opal Miners Association reconnected Patrice with his childhood memory when they rang to ask him about researching the origin of opal.

COCKROACHES AVOID SWEET POISON

FROM DR KARL KRUSZELNICKI'S 'GREAT MOMENTS IN SCIENCE'

Cockroaches have been around for a very long time. In fact, from about 360-300 million years ago (back in the Carboniferous period, when a lot of coal beds were laid down) roach-like insects made up about 40 per cent of all insect species. Now here is a weird fact — even after all that time, they are still evolving right in front of our eyes.

Today there are some 5,000 species — but only a few of them live in our houses. In general, the big guys (up to 40 millimetres long) are the American cockroach while the little guys (up to 16 millimetres long) are the German cockroach. They are difficult to control because they reproduce very quickly, are active at night when we are asleep, can go for a month without food, will eat each other if times are tough, and they live in nooks-and-crannies that you can't get to. And the other trick is that some of them have evolved to not like sweet things.

Now most forms of life like sweet stuff. 'Sweet' usually means some kind of sugar, and sugars mean easily accessible food. What's not to like?

Back in the old days, the only way to deal with a cockroach was the shoe method, or if you were a bit squeamish and wanted a bit of distance, a rolled-up newspaper. Then we invented poisonous sprays that would kill the dreaded cocky. And after that we invented baits. These were little packets of sweet stuff to attract the cockies, with a hidden deadly load of poison. But then the cockroaches began avoiding the baits.

How did they know?

The clever German cockroaches somehow evolved another survival trick. Some of them have switched around their chemistry-of-tasting, so that sugar now tastes bitter instead of sweet. As a result, when they come across a poison bait tasting of lovely sweet glucose, they avoid it — because it doesn't taste sweet any more.

Big question — how do cockroaches taste the world around them. Cockroaches don't have a tongue loaded with tastebuds like we do. No, they have little 'tasting' hairs all over — on the legs, feet, wings and yes, around the mouthparts. Inside these hairs are specialised receptor cells that respond to 'sweet' or 'bitter'. The entomologists concentrated on the tasting hairs around their mouthparts.

Let's call the German cockroach populations that hate glucose the 'glucose-averse' cockroaches. As for the regular cockroaches that love glucose, let's call them 'regular cockroaches'.

The entomologists found that in your regular cockroach some of these receptor cells would respond only to glucose, while others would respond only to something bitter such as caffeine. Furthermore, in the regular cockroach, the receptor cells that responded to bitter would not respond at all to glucose — and vice versa.

But the situation was very different in the cockroaches that run away from sugar — the glucose-averse cockroach. Give these guys some glucose, and yes, the glucose-sensitive receptor cells would fire — but more weakly than normal. As for the receptor cells that should respond only to bitter — there was a huge surprise. Somehow, the chemistry had been turned around. In the glucose-averse cockroaches, not only would these bitter-sensitive cells respond to glucose, they would do so more strongly than the glucose-sensitive receptor cells would do.

So overall, what happens when the glucose-averse cockroaches taste glucose? The glucose-sensitive hairs fire weakly while the bitter-sensitive hairs fire strongly.

Result? The glucose-averse cockroaches run away and don't eat the sweet poison and live — and have lots more babies, who inherit the behaviour and who would also hate glucose.

Now there are three theories about how this rapid evolution could have happened.

First, out of the untold billions of German cockroaches that live in cosy harmony with us, a few spontaneously had a mutation that turned the sensation of sweetness into bitterness. The regular cockroaches died because they ate the poison, while the mutated ones bred very rapidly to fill the empty ecological niche in our kitchens.

The second theory is that there already was, from the distant past, a section of the cockroach DNA that hated glucose. After all, while in most cases 'sweet' means 'food' and 'bitter' means 'poison', there are some sweet poisons called 'glycosides'. And perhaps this bit of the cockroach DNA was just sitting there waiting to be reactivated, in case cockroaches came across some sweet-tasting poisons again.

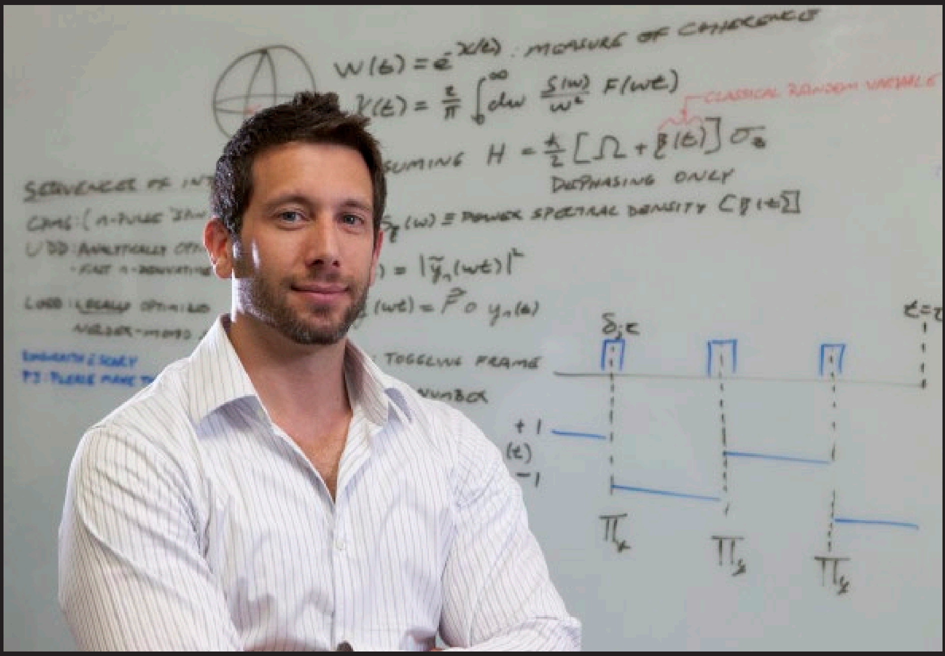
And the third theory is that perhaps the German cockroaches bred with other cockroaches that already had this mutation.

The result is mixed — they get to live, but they don't enjoy the sweet things of life. Imagine having to give up a whole food group. It's a bitter-sweet victory for the cockroaches…

MAKING MEMORIES - PRACTICAL QUANTUM COMPUTING IS ONE STEP CLOSER

BY KATYNNA GILL

A team from the University of Sydney and Dartmouth College in the US, have realised a major breakthrough, developing a new approach to preserving quantum states for exceptionally long times in a quantum memory.



Dr Michael Biercuk, Director of the Quantum Control Laboratory in the University of Sydney's School of Physics and ARC Centre for Engineered Quantum Systems, led a team who have developed a new approach to preserve quantum states for exceptionally long times in a quantum memory.

Quantum computing may one day revolutionise information processing, by providing a means to solve problems so complex that no classical computer could ever hope to solve them, with applications in codebreaking, materials science, and physics. But figuring out how to engineer such a machine, including vital subsystems like quantum memory, remains elusive.

A team from the University of Sydney and Dartmouth College in the US, have realised a major breakthrough, developing a new approach to preserving quantum states for exceptionally long times in a quantum memory, with details published in Nature Communications on 19 June 2013.

"We've developed an entirely new way of designing a practically useful quantum memory, which is a key need for future quantum computers," said Dr Michael J. Biercuk, Director of the Quantum Control Laboratory in the University of Sydney's School of Physics and ARC Centre for Engineered Quantum Systems.

The team led by Dr Biercuk includes University of Sydney Honours student Jarrah Sastrawan, research fellow Dr David Hayes, and PhD student Todd Green, with the work carried out in collaboration with colleagues from Dartmouth College, Dr Kaveh Khodjasteh and Professor Lorenza Viola.

In the worldwide drive to build a useful quantum computer, the simple-sounding task of effectively preserving quantum information in a quantum memory is a major challenge.

"One of the biggest challenges in quantum systems is error susceptibility. The very same physics that makes quantum computers potentially powerful also makes them likely to experience errors, even when quantum information is just being stored idly in memory. Keeping quantum information 'alive' for long times while remaining accessible to the computer is a key problem in the field," explained Dr Biercuk.

The research community, including Dr Biercuk's team, has spent considerable effort on figuring out how to prevent errors, translating techniques from control theory into the quantum regime.

With these new results the team has demonstrated a path to what is considered a holy grail in the community: storing quantum states with high fidelity for exceptionally long times - even hours according to their calculations. Today, most quantum states survive for tiny fractions of a second.

"Our new approach addresses key issues in engineering a useful quantum memory. It allows us to simultaneously achieve very low error rates and very long storage times. But our work also addresses a vital practical issue - providing small access latencies, enabling on-demand retrieval with only a short time lag to extract stored information."

The team's new method is based on special techniques to build in error resilience at the level of the quantum memory hardware. These are the basic protocols that last year earned Dr Biercuk a place as a finalist for the Eureka Prize for Innovations in Computer Science.

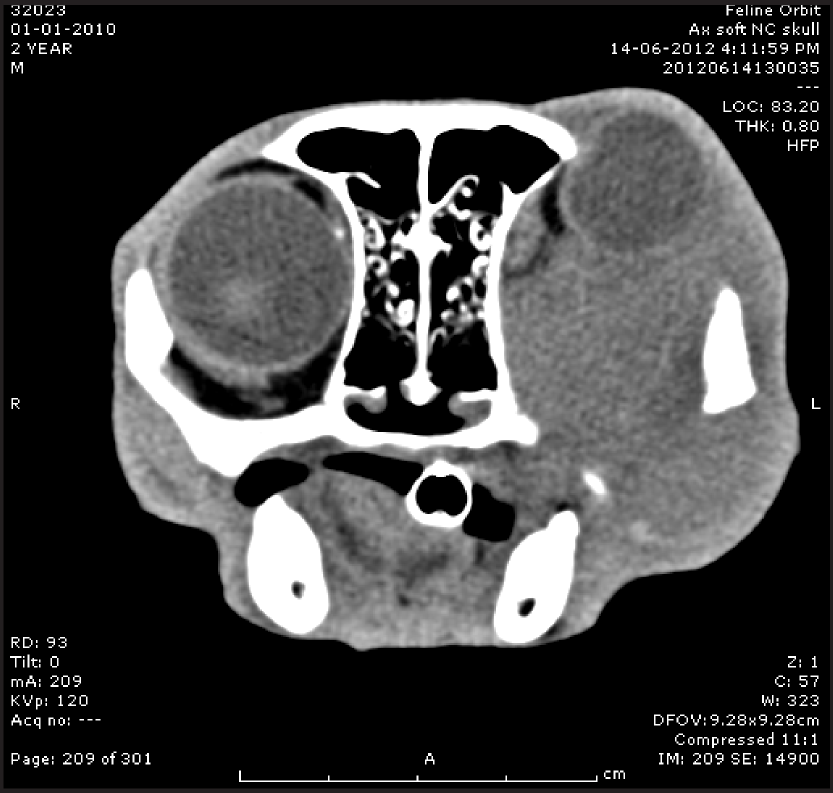
"We've now developed the quantum 'firmware' appropriate to control a practically useful quantum memory. But vitally, we've shown that with our approach a user may guarantee that error never grows beyond a certain level even after very long times, so long as certain constraints are met. The conditions we establish for the memory to function as advertised then inform system engineers how they can construct an efficient and effective quantum memory. Our method even incorporates a wide variety of realistic experimental imperfections," said Dr Biercuk.

The new results continue the team's success in bringing quantum computers closer to practical reality. Last year Dr Biercuk and colleagues demonstrated a special-purpose quantum simulator with computational potential so extraordinary it would take a standard supercomputer larger than the known universe to match it.

A FELINE FUNGUS JOINS THE NEW SPECIES LIST

BYVERITY LEATHERDALE

A new species of fungus that causes life-threatening infections in humans and cats has been discovered by a University of Sydney researcher.



"This all originated from spotting an unusual fungal infection in three cats I was seeing at the University's cat treatment centre in 2006," said Dr Vanessa Barrs, from the University's Faculty of Veterinary Science, whose findings have just been published in PLOS One.

"These cats presented with a tumour-like growth in one of their eye sockets, that had spread there from the nasal cavity. The fungal spores are inhaled and in susceptible cats they establish a life-threatening infection that is very difficult to treat."

Six years of investigation followed, including working with some of the world's leading fungal experts at the CBS-KNAW fungal biodiversity centre in The Netherlands.

"Finally I was able to confirm this as a completely new species, Aspergillus felis, which can cause virulent disease in humans and cats by infecting their respiratory tract. We were able to demonstrate that this was a new species of fungus on a molecular and reproductive level and in terms of its form.

"Similar to the closely related fungus Aspergillus fumigates, this new species of fungus can reproduce both asexually and sexually - and we discovered both phases of the fungus."

Since the first sighting of the new species, more than 20 sick domestic cats from around Australia and one cat from the United Kingdom have been diagnosed with the fungus.

The fungus appears to infect otherwise healthy cats but in the two humans identified it attacked an already highly compromised immune system.

The disease is not passed between humans and cats but its study in cats will not only help their treatment but provide a good model for the study of the disease in people. There is only a 15 percent survival rate of cats with the disease and it has so far proved fatal in humans. To date only one case has been identified in a dog.

"We are right at the start of recognising the diseases caused by this fungus in animals and humans. The number of cases may be increasing in frequency or it may just be we are getting better at recognising them," Dr Barrs said.

"Fungi like Aspergillus felis can be easily misidentified as the closely related fungus Aspergillus fumigatus, which is a well-studied cause of disease in humans. However, A. felis is intrinsically more resistant to antifungal drugs than A. fumigatus and this has important implications for therapy and prognosis."

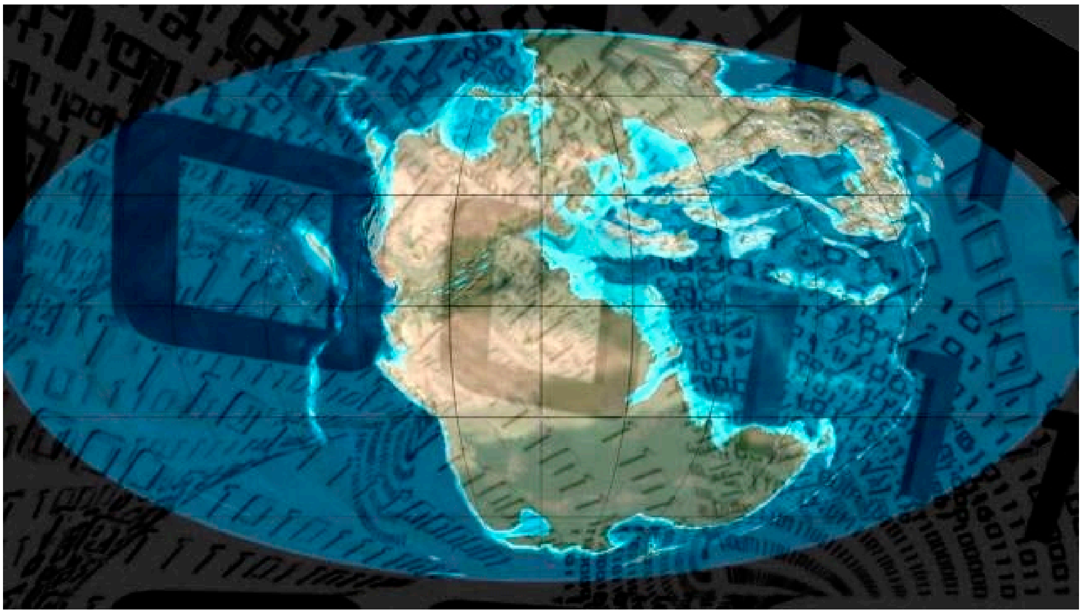
The next step for Dr Barrs and her team is studying fungi in culture collections throughout Australia to determine the prevalence of A. felis infections in people with previously diagnosed aspergillosis. They will collaborate with researchers at the Westmead Millenium Institute for Medical Research.

(Left) A cat with a swollen eye due to a fungal granuloma in its eye socket. (Right) The same cat after being successfully treated. The disease has only a 15 percent survival rate.

STOCK MARKET DATA MINING LEADS THE WAY FOR MINING INDUSTRY

BY VERITY LEATHERDALE

Analytical methods used to predict stock market movements will be applied to Australian geological data, collected over many decades, to model the evolution of the Australian continent and pinpoint new mineral deposits.



This research will look at geological data as far back as 1.5 billion years ago, before today's continents were formed.

The strategy is part of the $12 million Big Data Knowledge Discovery project, in which computer scientists, financial analysts and natural scientists are combining their expertise in a groundbreaking effort to discover information hidden in massive, multi-layered data sets.

"In the past year, investment in high-risk mining exploration in Australia has plummeted. Any information that can improve the accuracy of such 'greenfield' exploration would obviously be highly valued," said Professor Dietmar Muller from the University of Sydney.

"Part of the exciting potential of this project is that by applying algorithms used to predict stock market movements to the detailed data sets we have on Australia's geology, we hope to be able to uncover regions which have the highest likelihood of having exploitable mineral deposits buried hundreds of metres under weathered surface rocks."

Professor Muller, a specialist in earth dynamics and tectonics from the University's School of Geosciences, is part of the multidisciplinary team working on the project.

Together with natural scientists from Macquarie University specialising in terrestrial ecology and complex lasers, Professor Muller will join experts in machine learning and analytics from NICTA and in software and big data from SIRCA.

NICTA is Australia's Information and Communications Technology Research Centre of Excellence and SIRCA's technology is used by over 400 leading institutions in the financial services industry worldwide. SIRCA technology, in partnership with Thomson Reuters, powers the largest and most comprehensive research database of historic financial markets data in the world.

"Working together we plan on developing a new space-time data mining approach, exploiting similarities with other research fields such as finance and taking a new look at huge geo-data sets to unravel the structure and evolution of Australia in a global context," Professor Muller said.

"At the University of Sydney we have previously had success in applying big data mining for earthquake hazard mapping and opal exploration."

The Big Data Knowledge Discovery project will use national geological data, made available by Geoscience Australia, to reach back up to 1.5 billion years into 'deep time'.

"At that time Australia was made up of at least five smaller continents separated by ancient ocean basins and volcanic arcs which are now destroyed or deeply buried in the crust. Some of the world's richest metal deposits were formed during this period, but the reasons are not fully understood," said Professor Muller.

"This project will explore a new and powerful paradigm for data intensive science, ranging from medical and health sciences to physics," said Professor Hugh Durrant-Whyte, CEO, NICTA.

"Motivated by the grand challenges of big data, this initiative brings together world leading experts in finance and geoscience - possibly for the first time. SIRCA is very excited by this opportunity for two such diverse disciplines to work collaboratively towards a common goal," said Dr Michael Briers, CEO, SIRCA.

This project is supported by $4 million from the Science and Industry Endowment Fund.

STRANGER THAN NON-FICTION

BY VANDA NORTHWOOD

A group of undergraduate students from the University of Sydney are raising awareness about synthetic biology through a creative writing challenge.

Eight undergraduate students from different specialisations - biology, biochemistry, chemistry, mathematics, medical science, information technology, economics and anthropology - have come together as the first team representing the University of Sydney to compete at an international competition in synthetic biology.

The competition is iGEM, the international Genetically Engineered Machine. Student teams from over 200 universities around the world are given a kit of biological parts from the 'Registry of Standard Biological Parts', or the 'iGEM Registry'. Working at their own institutions, they use these and new parts they've designed to build biological systems and operate them in living cells.

Dr Nick Coleman, from the School of Molecular Bioscience, and Dr Peter Rutledge, from the School of Chemistry, are supervising the University of Sydney team as they attempt to modify a soil bacterium, Pseudomonas stutzeri, so that it can degrade dichloroethane.

Robbie Oppenheimer, one of the eight-member team, said, "Dichloroethane is a suspected carcinogen, it is toxic to humans and it contaminates the groundwater at Botany Bay as a result of a long and complex history of industrial activity in the area. Our work represents an interesting application of Dr Coleman's research into naturally transformable bacteria, and we hope to produce publishable findings."

In addition, some of the genetic material the team characterises will also be submitted to the 'iGEM Registry', which is a growing collection of genetic parts that can be mixed and matched to build synthetic biology devices and systems.

As part of the competition, each iGEM team is also required to raise awareness of synthetic biology in the wider community. The University of Sydney team is running the 'Strange Nature' writing competition as their awareness raising activity.

Team member Andrew Tuckwell explains, "As a group, we thought a writing competition would be an interactive and imaginative way to educate budding scientists."

The 'Strange Nature' competition is aimed at high school students. Hosted online, the competition provides an introduction to genetics, links to exciting current applications of synthetic biology, a quiz targeting common misconceptions, and more.

The website also provides lesson plans and teacher resources. Science teachers are invited to use the online competition to encourage discussion of synthetic biology in their classrooms.

With support from the University of Sydney's Faculty of Science and the Deputy Vice Chancellors of Education and Research, the University of Sydney iGEM team will be able to attend the regional iGEM jamboree in Hong Kong this October for the awards presentation and the announcement of the top three regional finalists.

To find out more about 'Strange Nature' and enter the competition visit: www.strangenature.org

MEASURING CARBON IN SOIL TAKES A LEAP FORWARD

BY VERITY LEATHERDALE

A breakthrough in the agricultural sector's ability to measure soil carbon storage could provide a major boost to their participation in a carbon economy.

Researchers at the Soil Security Laboratory at the University of Sydney have developed an instrument, the soil carbon bench, which can determine carbon levels from much larger samples, with greater accuracy and lower cost, than any existing technology.

The soil carbon bench (SCB) and its first results were presented this week at the International Union of Soil Sciences Global Soil Carbon Workshop, held at the University of Wisconsin, Madison. The Faculty of Agriculture and Environment research team consists of Robert Pallaser, Associate Professor Budiman Minasny and Professor Alex McBratney.

"The agricultural sector in Australia has the potential to capture and store carbon emissions in soil. However there is no guarantee that the industry can benefit from the offsets in the current and future carbon economy because until now there has not been a good and efficient way of measuring soil carbon storage with statistical confidence," said Professor McBratney.

PhD researcher Robert Pallasser has been developing an instrument to extract and accurately quantify soil from cores up to a metre in length, which yield samples of 300 to 500 grams of soil for analysis after initial drying.

"This is a new concept for measuring carbon stocks where it can be extracted from whole soil cores and analysed immediately," said Associate Professor Minasny.

"This is a great advantage over the current method that relies on 'point analyses' of a highly variable quality based on 0.5 gram amounts of soil at a time because current instruments are limited to these miniscule amounts.

The current methods of soil carbon analysis are very labour intensive. To ensure a representative sample with elements from all parts of the core, they have to be crushed, homogenised and carefully sampled again. The new method can get an accurate representation of the variability of carbon in soil over space and depth without this costly process.

Capturing carbon in soil or sequestration has been held back by the absence of an easy to use and reliable method. Sequestration promises major environmental benefits from capturing carbon which also, by increasing the organic matter in the soil, improves productivity and resistance to land degradation.

"To pursue sequestration and the participation of farmers in a carbon market successfully we need cost-effective, accurate measurements of carbon in soil so the potential for this technology is exciting," said Robert Pallasser.

The researchers plan to continue field testing the SCB while working on automating its components.

BOK PRIZE FOR RESEARCH THAT BREATHES NEW LIFE INTO ASTRONOMICAL IMAGES

BY VERITY LEATHERDALE

Research using a new technique to analyse archival images from the Hubble Space Telescope has won a University of Sydney PhD student the prestigious 2013 Bok Prize.

Ben Pope yesterday received the highest award given by the Astronomical Society of Australia for research conducted by an honours student.

Pope's citation from the Astronomical Society singled out the important potential for new discovery of his research by delivering the first scientific results with a new image analysis technique. The research promises to breathe new life into high resolution astronomical imaging.

"The Hubble Space Telescope has been a truly remarkable observatory, but despite the extreme competition to use it, a lot of the images taken with it have never been analysed to their full potential," explained Pope.

"The data I used for my research was mostly taken around 2005... and it had been sitting on a public archive since then. This data had previously been studied by simple visual inspection, but contained a hidden trove of discoveries accessible only after advanced computer processing."

"The thing that made all the difference for us was being able to apply the very latest leading-edge image analysis technique called kernel phase interferometry. I was fortunate enough to learn about this straight from its inventor, Dr Frantz Martinache, on a visit to Hawaii last year. Together we made the first new discoveries with this powerful new approach," said Pope.

It turns out that despite all the effort and expense, even the multi-billion dollar Hubble Space Telescope does not yield absolutely perfect vision.

The mirrors, lenses and other components that comprise the telescope all bend and warp by tiny amounts as the observatory orbits in space, enough to create subtle shifts in the image that are easy to confuse with real signals from the star being studied. The key breakthrough came with the realisation that the structure in the image could be mathematically divided into two classes: firstly those which could arise from errors in the mirror, and critically, a second class which could not.

"In essence, we divide the image into two parts," explains Dr Martinache, "The first can be corrupted by optical problems, and we discard this. Kernel phase interferometry can then focus exclusively on information in the image which is essentially immune to the noise. It is like a noise-cancelling headset on an aeroplane: you flick off the noise and you can suddenly detect all these faint signals nobody else could find."

Pope's research unleashed this method in the hunt for companions to the intriguing objects known as brown dwarfs which occupy the no-man's-land in mass between gas giant planets like Jupiter, and the smallest, dimmest stars.

"Brown dwarfs are like a missing link between stars and planets, and by studying them we learn more about how the great diversity of star systems in the universe came to be formed," said Pope.

"Although they are incredibly faint, so we never see them except with large telescopes, they are actually very common. Most importantly, nobody is quite sure how they can be formed, and they present a tricky challenge to just about all theories for how matter collapses to form compact bodies like stars and planets ... In particular, one of the key tests is to find how often brown dwarfs are found in pairs."

This pairing, or binary factor, is quite high for stars - the in-joke among astronomers is that three in every two stars is a binary.

"What my work here has shown is that it is in fact also higher than previously thought for brown dwarfs too," said Pope.

"You can't help but feel a little poignancy for brown dwarfs ... out in the cold reaches of the galaxy, never to see a sunrise and doomed to slowly freeze as generations of stars around them are born and die," said Professor Peter Tuthill, Pope's research supervisor.

"I guess Ben's work gives the poets in us a little solace, in that more of them than we expected are in a stately orbital dance with a partner that will still be going when our own sun has lived its entire life and is but a memory."

Mr Pope's award marks a hat-trick for the University's Sydney Institute for Astronomy which has won this national prize three years in a row with past winners Alison Hammond (2012) and Barnaby Norris (2011).

Dancing in the Dark: New Brown Dwarf Binaries from Kernel Phase Interferometry, Pope, Martinache and Tuthill, is now published in the *Astrophysics Journal*.