CONTACT

NEWSLETTER OF THE FACULTY OF SCIENCE • DECEMBER 2014
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SOME ARTICLES IN THIS ISSUE

Message from the Dean

Welcome to this 2014 edition of "Contact" – our formal UCT Science Faculty publication aimed at maintaining contact with our alumni, and which conveys some of the many Faculty highlights over the past year. The year started on a sad note with news of the tragic loss of Professor Gary Marsden, ever popular with the students, distinguished teacher of note, and a world leader in the field of human – computer interactions. His loss will be felt for some time. For the Science Faculty it was a productive year, with numerous staff and students receiving prestigious awards of recognition for their teaching or research. Progress was made with improving undergraduate student throughput, postgraduate numbers continued to grow, and research activity in the Faculty flourished, despite on-going pressure on funding for basic research.

A number of our staff were rewarded for their excellence in research, with prestigious national and international awards, and it is particularly gratifying to see the strength of our younger staff in this regard. Equally satisfying were the number of national and international awards that our undergraduate and postgraduate students garnered, which bodes very well for the future of Science in the country.

2014 was a particularly good year in regard to postgraduate training with 82 PhDs graduating – an all-time high for the Faculty. Registered PhD students reached a record number in excess of 400, whereas Master's students topped 475. It is particularly pleasing to note that our postdoctoral fellows also continue to grow despite funding pressure, and with 153 registered in the Faculty constitute over half the total number at UCT. At staff level, there was something of a changing of the guard, with 10 senior staff retiring in December 2014. Collectively, and individually, they represent an immense loss to the Faculty – in performance, impact and wisdom. Despite the loss, I am confident the void will be filled by the many outstanding younger staff we are privileged to have in our ranks, including a number of new appointees.

An important advance was the development of a major new research strategy aimed at addressing the need for the Science Faculty to further increase its international visibility and impact in a world of tightening resources. Following the international review of our research in 2013, and after many discussions within the Faculty, the Faculty Board approved a new Research Strategy, aligned with the new UCT Research Strategy, which will focus our Faculty efforts in six broad domains, in which we will strive to become international leaders. The six areas are: African Climate and Development; Biodiversity and the Cape Floristic Region; Chemistry & Biology for Health in Africa; Human Evolution & the African Quaternary; Marine Biology and the Southern Oceans;

Southern Skies and the Evolving Universe. I look forward to seeing our international impact growing in these areas in the coming years.

In the following pages, we report on some of the awards received by staff and students, and thereafter a few short articles capture some of the interesting scientific research that is being done by members of the Faculty.

I hope that you enjoy this 2014 edition of *Contact*, and please remain in touch with us.

Anton le Roex
Professor of Geochemistry
Dean of Science

SOME FACULTY ACHIEVEMENTS IN 2014

A number of Science Faculty staff and student were privileged to be recognised for their achievements through a range of awards and election to executive positions of national and international bodies. The committed performance of Science Faculty staff, many of whom are world leaders in their field, and the achievements of students, is a source of pride for the Faculty and is the corner stone of continued recognition of the Faculty both locally and internationally for its excellence in teaching and research. The following short synopses capture some of the achievements and awards of our staff and students during 2014.

Staff Achievements and Awards

» **Professor Daya Reddy** from the Department of Mathematics & Applied Mathematics was named the next President of the International Council for Science (ICSU). Professor Reddy is presently the President of the Academy of Science in South Africa as well as the Director of the URC accredited Centre for Research in Computational and Applied Mechanics (CERECAM). Deputy Vice Chancellor Professor Danie Visser acknowledged that "Professor Reddy's election is not only a feather in the cap of UCT, but of the South African science community as a whole for its achievements and contributions to science dialogue and exchanges, and for ultimately helping to address global challenges. This international leadership position will enable UCT and our country's science community to bring more African-born solutions to the table, when appropriate, and to accentuate the science breakthroughs made in the developing world."

» Two Science Faculty staff, **Professors Russ Taylor and Patricia Whitelock**, both from the Department of Astronomy, were recognised in 2014 as international leaders in their respective fields of research by receiving A-ratings from the National Research Foundation. This is a singular achievement in the national research system and they join 14 others in the Science Faculty who hold this prestigious recognition. Professor Taylor, who is the international project leader for the design of the global data-delivery system for the SKA project, took up UCT/UWC SKA Research Chair in radio-astronomy early 2014. He has been involved with the SKA project since its inception and will assist the Faculty in playing a leading role in the science programme that is being developed. Professor Whitelock holds a joint UCT – South African Astronomical Observatory (SAAO) position in the Department of Astronomy, and is internationally recognised for her research in observational Astronomy, focussed on the late stages of stellar evolution. She has used measurements made with the telescopes at SAAO, combined with observations from various spacecraft, to study the process of mass-loss from single and binary stars over timescales of decades. This is of interest in understanding how important elements, such as carbon, are redistributed after their formation near the centres of stars.

» **Professor Steve Richardson** from the Department of Geological Sciences joined the ranks of Science Faculty staff who have been inducted into the prestigious College of Fellows at UCT. Professor Richardson's award was in recognition of his life-time contribution and international leadership in the study of diamond formation and the geochemical evolution of the subcontinental lithospheric mantle, and in particular his body of work using minute silicate and sulphide inclusions found in diamonds to determine their age and the composition of the fluids and processes that led to their formation.

» **Associate Professor Coleen Moloney** from the Department of Biological Sciences and director of the Marine Research Institute (Ma-Re) was the first woman marine scientist to win the Gilchrist Memorial medal, in recognition of her research into the variability of marine food webs and ecosystems under global change and the influences of fishing and pollution on marine systems.

The citation for her award lauded her services to marine science: " … many of her activities are in the service of others, rather than promoting her own self-good. Large proportions of her research grants are devoted to bursaries and funding needed to support students, particularly those from a previously disadvantaged background. She is much in demand because of her efficiency and wise counsel. She truly is a team player, dedicated to the promotion of marine science."

» Three young staff in the Faculty, **Drs Andrew Hamilton** (Department of Physics), **Deena Pillay** (Department of Biological Sciences) and **Vanessa McBride** (Department of Astronomy), received Claude Leon Merit Awards for Young Scholars. Physicist Dr Hamilton, who holds a prestigious P-rating from the NRF, is one of the researchers participating in the decade-long experiment to detect the elusive Higgs boson. He is using the award money to build a video-conferencing system to ensure better communication with collaborators at CERN (European Centre for Nuclear Research).

Dr Pillay, a marine ecologist, intends to continue one of his driving interests: highlighting the importance of all species in ecosystems. "Often people are unaware of how things are linked in an ecosystem. I am hoping my research will take the information to the public to show them that there have been periods where we have been responsible for mass extinctions of species, which ultimately impact on us," said Dr Pillay.

Dr McBride's research uses optical, infrared and X-ray observations of neutron stars accreting material from normal stars to learn about the evolution of these systems, and to trace star formation in our galaxy and our neighbouring Magellanic Clouds. The award was used for travel to the Be X-ray binary conference in Valencia, during July 2014, where Dr McBride and her student presented their results.

SOME FACULTY ACHIEVEMENTS IN 2014

»Other staff who have receive national recognition include **Associate Professor Michelle Kuttel**, from the Department of Computer Science, who was one of four UCT scientists recognised by the Department of Science and Technology in acknowledgement of their "outstanding scientific contribution to advancing and building the knowledge base in their respective disciplines", as part of their annual Women in Science Awards. **Professor Jill Farrant** was again in the headlines by being named as one of the 21 ICONS of South Africa for her work on plant responses to water deficit stress. **Professor Renee Kraan-Korteweg**, kept the Astronomy flag flying high by being elected chair of the newly convened Astronomy Advisory Council, which will oversee and advise the NRF's Astronomy sub-Agency, and was also elected as Vice President of the International Astronomy Union, where she will serve two terms of three years.

»Staff who have continued to make major contributions to the Faculty since retirement include **Emeritus Professor Luigi Nassimbeni** and **Honorary Professor Michael Feast**. Professor Nassimbeni, who holds a position of Senior Scholar in the Department of Chemistry, was recognised with a long service award at the 2014 Pan African Crystallography Conference in Bloemfontein, held in celebration of the International Year of Crystallography, for his standing as "An outstanding scientist and inspiring teacher, contributing to crystallography in South African for over 40 years". Professor Feast, Department of Astronomy, was awarded the prestigious John F. W. Herschel Medal by the Council of the Royal Society of South Africa. The award was in recognition of his multidisciplinary contributions to science in South Africa, his international standing and research productivity as both a physicist and an astronomer.

Distinguished Teacher Awards

High quality teaching remains an important expectation in the Faculty, and two Science Faculty staff were rewarded for their exceptional commitment to innovative and inspiring lecturing – **Dr Spencer Wheaton**, Department of Physics, and **Associate Professor James Gain**, Department of Computer Science, received 2014 UCT Distinguished Teacher Awards, the highest accolade given to lecturing staff in acknowledgement of the value UCT attaches to teaching and learning.

Associate Professor Gain is an inspiring teacher who makes complex material enjoyable and understandable and is innovative in his use of learning devices. He engages students by incorporating interactive in-class exercises and encourages them to grapple with problems in different ways. He has been innovative in supporting in-class learning via the use of polling instead of costly clickers, to check understanding in class and gamification to improve student engagement and provide impetus for active learning.

Dr Wheaton is an enthusiastic teacher, a "natural" who teaches with care and innovation. He promotes active engagement in class and makes a conscious effort to phrase questions in a way that promotes understanding with clear explanations of theoretical concepts. His reflective teaching practice is captured by his acknowledgement that he is always learning from students and is dedicated to understanding how to teach better.

Social Responsiveness Award

»One of two UCT Social Responsiveness Awards for 2014 went to **Associate Professor Sophie Oldfield** of the Department of Environmental & Geographical Science, in recognition of a decade-long collaboration with Gertrude Square and the Valhalla Park United Front Civic Organisation, a Cape Town community organisation formed in the 1980's to challenge apartheid-era evictions. Together, they have built a research-teaching partnership through which university-based research methodologies and activist research imperatives have been combined to build a body of neighbourhood knowledge. In the process they have taught hundreds of UCT students about the imperatives of community mobilisation and the realities of township poverty.

SOME FACULTY ACHIEVEMENTS IN 2014

Student Awards and Achievements

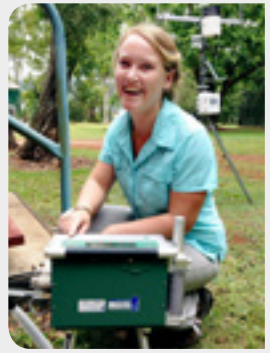
Science Faculty students excelled in a variety of fora in 2014 and carried the torch of excellence to a wide range of places, events and awards.

» PhD student **Maletsabisa Molapo**, from the Department of Computer Science, was recognised by the Department of Science and Technology, as part of their annual Women in Science Awards, in acknowledgement of "outstanding scientific contribution to advancing and building the knowledge base in their respective disciplines". Ms Molapo specialises in the use of information and communication technologies (ICT) for development. Through her research she explores the ways in which ICTs can be used to empower communities, especially women and youth. She has led the team that founded the Her Chance to Be Foundation, a non-profit organisation committed to improving the lives of women and girls in Lesotho. The organisation focuses on education, health, livelihood and access to technology. Ms Molapo's PhD research explores how the training of community health workers and the health education of rural communities in Lesotho can be improved through a multimedia learning platform that supports the local creation, distribution and consumption of digital health content.

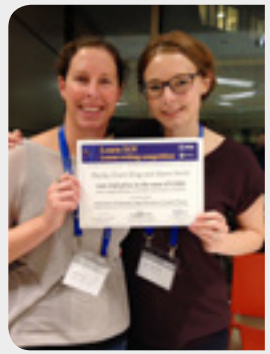
» Science Faculty computer programming teams continued to dominate nationally and swept the boards at the inter-university 2014 National Standard Bank CIB IT Challenge, placing 1st, 2nd, 3rd, 4th and 6th. The winning team of this prestigious national event was **Ashraf Moolla**, **Dylan Nelson** and **Robert Spencer**. Second position went to **Kieren Davies**, **Yaseen Hamdulay, Rosy Sanby** and **Sean Wentzel** and third was **Shaylan Lalloo, Reneshan Naidoo** and **Darien Naidoo**. Fourth place was also taken by a UCT team comprising **Aaron Krishna, Guy Paterson-Jones, Herman Pienaar** and **Nicola Vermeulen. Calvin Brizzi, Bryce Billing** and **Jethro Muller** placed sixth among over 60 participating teams from 11 universities. Two other students from the Department of Computer Science who were recognised nationally were **Chao Mbogo** and **Imaculate Mosha** who walked away with the two *South African Google Anita Borg Memorial Scholarships*, which aim to encourage women to excel in computing and technology.

» PhD student **Lova Marline**, Department of Biological Sciences, received the *Green Talents Award* – the prize for which is a ticket to the "Green Talents International Forum for High Potential in Sustainable Development", organised by the German Federal Ministry of Education and Research. Her outstanding academic record and PhD project on bryophytes as indicators of climate change were important in her being one of the 25 people selected from more than 800 applicants from 100 countries. Breaking new scientific ground in her study of the bryophytes of Madagascar, Lova is committed to investigating these plants as sensitive bio indicators of climate change.

» Two other Science Faculty postgraduate students who received international recognition for the quality of their research work were **Wunmi Isafade**, PhD student in Computer Science, and **Emma Gray** (pictured), recent MSc graduate in Biological Sciences, who were awarded the *L'Oreal-UNESCO for Women in Science Sub-Saharan Africa Regional Fellowship* for their work, respectively, in developing a situation–recognition system to increase public safety, and identifying determinants of plant growth rates. They will receive their prizes at a function in Paris.



» **Hayley Evers-King** and **Marie Smith**, postgraduate students in Biological Sciences, were amongst winners of the *2013/2014 LearnEO! Lesson* writing competition and received their prizes in Frascati, Italy in November. Their lesson looked at the "Detection of Harmful Algal Blooms in Coastal Waters: Examples using ocean colour radiometry from the Southern Benguela upwelling system". MSc student **Lise du Buisson**, from the Department of Mathematics & Applied Mathematics, brought considerable pride to the Faculty by the remarkable achievement of being awarded both a Rhodes Scholarship and a Fullbright scholarship, to undertake PhD research at Oxford or in the USA.



FEATURE ARTICLES

Galaxies in a Supermassive Tango

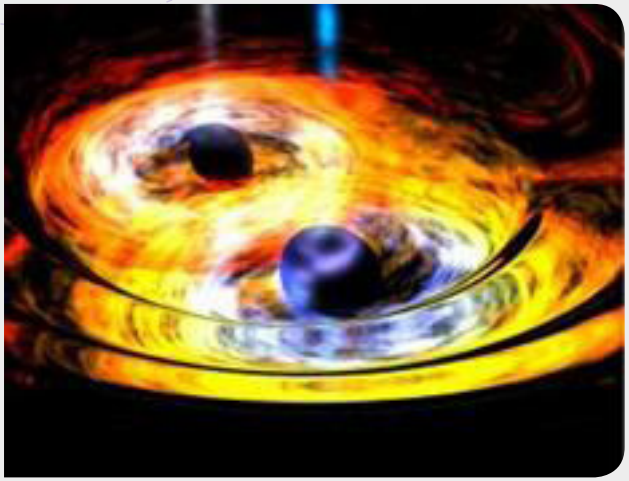


Figure: A tango to end all tangos (Illustration: NASA)

A team of international astronomers, led by UCT Professor Thomas Jarrett, from the Department of Astronomy and the South Africa Research Chair in Astrophysics and Space Science, has uncovered a rare astrophysical phenomenon that may produce powerful ripples through space. A pair of super-massive blackholes, each over a billion Suns in accumulative mass, are swirling at the center of the galaxy known as WISE J233237.05-505643.5. When two large galaxies collide and merge into one system, their central blackholes are expected to coalesce in a spiralling dance of death. Although galaxy mergers are relatively common, catching them in the act has been elusive for astronomers, with only a handful of such systems currently known, and none as large as the system found by the team of UCT, NASA and CSIRO astronomers.

These energetic phenomena are important to study because when the nuclei merge, effectively swallowing each other and creating a larger central blackhole, they release powerful gravitational waves, sending ripples through space that can be detected on Earth. Gravitational waves, predicted by General Relativity, are the last cornerstone of discovery for the famed theory of gravity first postulated by Albert Einstein. The work was published in the December issue (Vol 779) of the Astrophysical Journal.

Earliest Modern Human Sequenced

A research team led by a team from the Max Planck Institute for Evolutionary Anthropology (Leipzig, Germany), with participation of newly appointed UCT lecturer Dr Domingo Carlos Salazar García, from the Department of Archaeology (pictured to the right) has sequenced the genome of a 45,000-year-old modern human male from western Siberia. The comparison of his genome to the genomes of people who lived later in Europe and Asia show that he lived close in time to when the ancestors of present-day people in Europe and eastern Asia went different ways. Like all present-day people outside Africa the Ust'-Ishim man carried segments of Neandertal DNA in his genome. But these segments were much longer than the ones found in present-day humans and indicate that the admixture with Neanderthals took place between 50,000 and 60,000 years ago.

Stable isotope analyses of this early modern human, suggest that he consumed freshwater resources on a regular basis, something yet to be directly observed in Neanderthals. "These results are important, since the consumption of aquatic resources portraits a wide-spectrum dietary pattern for these Eurasian pioneer early modern human populations not observed yet for Neanderthals of the region", says Domingo Carlos Salazar García. "Probably the ability to have this dietary plasticity helped them to adapt to extreme northern environments, helping them in their Eurasian 'enterprise' compared to Neanderthals, which eventually disappeared", he adds. Stable isotope analyses are useful to find out information about regular consumption of different types of dietary protein resources, differently to faunal and plant studies that, although they show what types of foods were consumed by past populations, can't define their overall proportion in the diet of the individuals.

FEATURE ARTICLES

Remnants of class-based society found at Zimbabwe border

Dr Shadreck Chirikure, from the Department of Archaeology has a small packet of glass beads in a cabinet alongside his desk, collected from a hilltop in Zimbabwe by his research team. The beads are part of a ground-breaking discovery that could change much of what is known about southern Africa and one of its most lauded heritage sites. For many years Mapungubwe in Limpopo has been hailed as the site of the region's first class-based society, where the leaders were separated from the rest by dry-stone walls. But recently Dr Chirikure and fellow archaeologist Munyaradzi Manyanga, from the University of Zimbabwe, discovered the beads at the foot of a hill in Mapela, which could prove that Mapela is an older and more interesting site than Mapungubwe.

When Chirikure got to Mapela, he was surprised by how big the hill was and the fact that it was massively stone-walled. Navigating very poor access to the location, which is 13km from any roads, was a challenge, but once there with a team of students from UCT, University of Zimbabwe and Midlands State University, the layers of Mapela opened up like a treasure chest of clues to the history and a new way of thinking about what happened there. The deepest trench they excavated was two metres deep and they found glass beads, ceramics and grains of sorghum seeds there. Says Chirikure, "We got material for radio-carbon dating and suddenly it became clear: The enormous stone-walled terraces were constructed in the 11th century – almost 200 years before Mapungubwe – and it was bigger, so how could it be a province under the power of Mapungubwe?"

Chirikure and his team's research indicates that with a hilltop and flat area occupation since the 11th century, Mapela exhibits evidence of class distinction and sacred leadership much earlier than Mapungubwe and its neighbouring village, known as K2, the supposed propagators of the Zimbabwe culture. "This means that we are under-estimating the very nature and characteristic of urbanism in southern Africa over a span of 800 years. It opens our eyes to places that have been edited out of our very understanding of history," said Chirikure.

"We got material for radio-carbon dating and suddenly it became clear: The enormous stone-walled terraces were constructed in the 11th century – almost 200 years before Mapungubwe..."
– Dr Shadreck Chirikure

FEATURE ARTICLES

Life at Sea – exploring the Oceans on the Agulhas II

Dr Isabelle Ansorge, from the Department of Oceanography, took 5 women from the department on an expedition on the polar research vessel the SA Agulhas II earlier in the year. This "class afloat" is a training programme for Master's students and they spent 5 weeks doing hands-on research, having lectures, and examining the ocean dynamics in the Southern Ocean. For many students who have previously worked with the results from cruise data, this is their first time at sea and it brings new perspective on how the process happens, glitches that occur and how to translate the theory into practice. Students run a watch for 12 hours, where they work with technicians, collect samples and work on their own projects.

On this recent trip, Dr Ansorge recounts that there was one storm after another, with rough seas and the ship was pushed to the limit. The bad weather meant that the students spent a lot of time working up the data gathered, as well as planning future papers and another Master's project. She explained that being on the cruise is an opportunity for postgraduate students to explore future possibilities and where they want to go with their careers.

Being on the ship can feel like "ground-hog day" where one day can be the same as the next and you can't escape and retreat from people. This means that the cruise becomes a significant bonding experience and solid friendships are formed. Katherine Hutchinson, currently a research assistant and intern who assisted with the training of the Master's students, commented that you see the many sides of people as you work together in close proximity.

Departing from Cape Town on the ship, working at sea and walking on Marion Island.

The trip was not just about Oceanography but also included a 3 night sojourn on Marion Island, which is a natural laboratory for all natural Earth sciences and where students can see the bigger picture in this sub-Atlantic laboratory. This is a place where everyone works together, brainstorming ideas in the bar and looking at an integrated concept of the entire ecosystem and climate change with geologists and biologists. This was a highlight for the students, who particularly enjoyed heading out (even in the pouring rain) to see the penguins.

Over 17 years Dr Ansorge has taken more than 150 students to sea. So what inspires her to head off on a cruise? She explained, "This is a life experience and a golden opportunity: you can teach in class, but unless you experience it in the environment, what works and the complications and difficulties that can occur in getting the data, you don't get the full picture. You are also removed from everyday life, you don't get stuck in traffic and there is no need to shop for food or even cook! – you are a few minutes from your work and the gym – there is an ease of life."

Dr Ansorge is currently working on a proposal to attract Mathematics, Statistics, Engineering and Computer Science students into the marine environment. Her proposal for SEAmester entails a classroom at sea onboard the SA Agulhas II for two weeks each year, drawing 30 students from across South African universities and will strive to bring more of the numerical sciences into Marine Science. This will combine traditional class-room lectures with hands-on deck activities, providing students with an opportunity to support specialist scientists in internationally relevant research activities. The aim of SEAmester is to (a) make use of dedicated sea time to train a new generation of numerically proficient students entering the marine sciences, and (b) to undertake research in a region that has been identified by both the national and international community as critical to climate change.

FEATURE ARTICLES

Rarer than rhino and just as prized by poachers – Cycad plants

Dr Adam West from the Department of Biological Sciences has been developing a forensics system to track endangered cycads across the country. Critically endangered cycads are disappearing from the wild and botanical gardens, ripped up by the roots to feed the lucrative landscaping market. UCT researchers are using a novel method to help the Hawks combat the theft of these ancient plants. A method that has been used to trace cocaine, explosives and bank notes is being applied for the first time to help combat the illegal trade in cycads. In a paper published in the Journal of Forensic Sciences and reported on in Nature, Kirsten Retief and colleagues at UCT and the South African National Botanical Institute (SANBI) describe their use of stable isotopes and radiocarbon dating to identify cycads removed from the wild.

Cycads, the world's oldest seed plants – which have been in existence for 340 million years, are also the most endangered plant group on the planet. South Africa is home to 38 indigenous cycad species, and is therefore an important centre for cycad diversity; however, 12 of those species are critically endangered, and three of them are classified by SANBI as extinct in the wild. There are fewer than 100 cycads of the species Encephalartos latifrons left in the wild: it is this species that was targeted by thieves in two separate raids at Kirstenbosch National Botanical Garden in Cape Town in August 2014. The poachers stole 24 cycads, a haul worth more than R700 000.

"These plants sell by the centimeter," says Dr Adam West. "A large, rare plant will sell for around R400 000. When you put a price tag like that on a plant, there's an incentive." Trading in these endangered cycads is illegal – it is banned by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) – but enforcing the law relies on the ability to prove that a cycad in someone's garden came from the wild. A range of techniques has been used in the war on poachers, including microchips and micro-dotting: spraying the plants with 100 or more miniscule dots, each of which contains an individualised reference code. However, neither of these methods is fool proof. Poachers have taken to x-raying plants and digging out the microchips, and both methods rely on going into the wild and tagging each plant at risk.

"SANBI approached us for help in developing a technique to trace cycads that had never been seen before that showed up in suspicious locations," says West. "Cycads have very localised distributions, so we can characterise their environment relatively well using stable isotope composition." The researchers can take tissue out of the stems of the cycads at different points and link it back to its location. "There's a lovely chronology in these plants," says West. "The more recent tissue will reflect the chemical signature of the current location, whereas further down the stem the stable isotope composition of the tissue can be linked back to the wild."

When plants turn up in suspicious locations, UCT researchers turn detective. Kirsten Retief, a researcher with both UCT and SANBI, and Michèle Pfab, scientific co-ordinator at SANBI, have accompanied the Hawks and the Green Scorpions on raids in Gauteng. "I've been to a number of private gardens where owners of cycads claim they are legitimate, and yet you can see burn marks and porcupine bites on them," says Retief. "Our method will test their stories."

"The signature is locked in the plant's tissue": Dr Adam West of the Department of Biological Sciences explains the advantages of the method he and his team have developed to track cycads. *Photo by Michael Hammond.*

Inset: Encephalartos latifrons at Kirstenbosch Gardens. (Photo by BotBln, licensed under Creative Commons and accessed via Wikimedia Commons.)

"The advantage of this method," explains West, "is that the signature has been locked up in the plant's tissue, and you can't get rid of that. It's not like a microchip, which you can pull out. It's not like a DNA marker, which tells you about parentage but doesn't tell you about origin. And it's not like most methods where you have to go into the wild to label the plants – we can trace these plants without having seen them before."

FEATURE ARTICLES

Genetically engineered 'plantibodies' to halt Ebola

While little can be done to curb the current outbreak of Ebolavirus in Africa, "not legally nor ethically" without a licensed vaccine, with the next outbreak the world will be armed with powerful biologics made cheaply using plants, says UCT plant biotechnologist Professor Ed Rybicki from the Department of Molecular & Cell Biology.

Worldwide, governments have been on high alert to halt the spread of the disease, spotlighting the need for emergency vaccine technology: vaccines that can be made quickly, cheaply and safely. Biologics: drugs that can be created by genetically re-engineering plants or even plant viruses to produce vaccines and antibodies needed to curb diseases like the Ebolavirus, could be the answer. Biologics are not new, says Rybicki, a genetic engineer who heads up UCT's Biopharming Research Unit (BRU), but they are the latest growth area for pharmaceutical companies, and part of new approaches to disease prevention. And plants like the humble tobacco are key. Vaccine antigens, substances that provoke an adaptive immune response, can be made in plants. These antigens treat a host of diseases and cancers by mimicking proteins and other molecules found in disease-causing organisms, and eliciting protective antibodies in the human body. Recent attention worldwide has focused on making therapeutic monoclonal antibodies in plants. "These plant-made antibodies, or 'plantibodies', are completely safe for humans and will pave the way for low-cost therapeutics and change the way we treat viral and other diseases", adds Rybicki. "You can make a complex vaccine in plants that's as good as a conventional vaccine," he said in a recent TEDxCapeTown talk.

Mimicking nature: UCT's Biopharming Research Unit, headed by biotechnologist Professor Ed Rybicki, has been pioneering the technology underpinning biologics, a new generation of medications targeting diseases like the Ebolavirus.

"Because the main advantages vaccine farming has over conventional production are the speed of response and the extreme scalability of production, it should initially be used for 'niche' products such as emergency response vaccines and bioterror response vaccines." – Professor Ed Rybicki

While transient expression technology can produce antigens or antibodies in tobacco leaves in just a few days, and harvesting and processing them takes just a few more, the scale of production for therapeutics in particular can be huge, and the processing facilities very expensive, largely beyond African resources. Charles Arntzen of Arizona State University, the plant biologist who helped establish the "plantibodies" technology, points out it takes 30 to 50 kg of tobacco leaves for a single course of ZMapp, the US-Canadian experimental therapy antibody-based drug for Ebolavirus, and four-to-six months to get clinical-grade medicine. "Whereas testing of ZMapp on Macaque monkeys has been extremely successful, we don't know whether it works for humans because we haven't had a full-scale human trial," says Rybicki.

"Because the main advantages vaccine farming has over conventional production are the speed of response and the extreme scalability of production, it should initially be used for 'niche' products such as emergency response vaccines and bioterror response vaccines," says Rybicki. "This is because a short response time is vital in responding to unexpected outbreaks or incidents, and scale of production essentially depends only on how many plants are available, or needed – rather than on expensive and hard-to-expand fermentation facilities."

EVENTS IN THE FACULTY

INAUGURAL LECTURE

Professor Andy Buffler

Professor Andy Buffler from the Department of Physics gave his inaugural lecture, with the title of "Towards a philosophy of measurement in the science teaching laboratory" on the 26 September 2014.

He stressed that if the university is to do justice to its mission of producing science graduates of the highest quality, it needs to embed a philosophy of science that places the role of observation at the forefront of its curricula. Head of the Department of Physics, Professor Buffler spends much of his research time in the realm of applied nuclear physics, with much of his work focussed on positron emission particle tracking (PEPT) – an effective method of studying the flow of material using radioactive tracers. In partnership with Dr Indresan Govender (also from the Department of Physics) he established the second operational PEPT laboratory in the world a short drive east of UCT, at iThemba LABS.

Not only is Professor Buffler an accomplished researcher in nuclear physics, but he also takes great pride in passing on his expertise to students – a passion demonstrated in his early UCT career, which began with the Centre for Higher Education Development, and recognised in 2002 with a Distinguished Teacher Award.

DEAN'S VISITOR

Professor Rory Wilson

Professor Rory Wilson, from Swansea University, Wales, UK, recently delivered the Dean's Visitor lecture, entitled: "What can trendy transducers, vivid visualisations and fundamental physics tell us about wild animals and people?" Professor Wilson is head of department of Biosciences at Swansea University and is the recipient of multiple awards in recognition of his pioneering research, which takes him to extreme habitats from the Poles to the Equator and from the deep ocean to high mountain ranges. He studies leopards, sharks, albatrosses, elephant seals, armadillos and sloths, using a unique blend of multi-disciplinary science to unravel their remote lifestyles.

In his talk he shared some of his ingenious ways of tracking wild animals and recording their behaviour without directly observing them, utilising his inventions which harness the laws of physics, exploit innovation in electronics and computer science and rely on complex mathematical and statistical approaches to accurately estimate the energy expenditure of animals on land, at sea and in the air.

Over two hundred people attended the lecture and were treated to a truly outstanding and captivating presentation. Such was the interest generated that future collaborations are being planned.

DISTINGUISHED ALUMNI LECTURE

Back to the Future for African Ecosystems: How rising CO_2 is changing everything

UCT Alumnus **Professor Guy Midgley** presented this year's Distinguished Alumni lecture entitled "Back to the Future for African Ecosystems: How rising CO2 is changing everything." Professor Midgley is a professor at Stellenbosch University where he focuses on climate change and biodiversity research and teaching. He was previously Chief Specialist Scientist at the South African National Botanical Institute (SANBI) where he led SANBI's Global Change and Biodiversity programmes.

Professor Midgley's first slide was of the cover of The Economist with the title "Welcome to the Anthropocene"; he commented that once an environmental issue makes it onto the cover of the Economist, the penny starts to drop that these are important issues. Human beings are changing the planet so much that we may need to recognise a new geological era. He explained that we have lived in a CO_2 constrained world for several million years but that we could, in the next few decades, push the CO_2 levels to levels not seen for 50 million years. This represents a major evolutionary shock to modern ecosystems that have evolved under exceptionally low CO_2 levels of the past million years. In his talk he examined

how global distribution of the world's ecosystems and vegetation has long thought to be primarily controlled by climate but that it is increasingly clear that the level of atmospheric CO_2 plays an extremely important role.

Growth of "Super" plants: The talk highlighted how the diversification of African fauna and flora took place under low CO_2 levels and relatively cool climatic conditions and Professor Midgley indicated that the current levels will push fauna and flora to levels they have not previously experienced and have an impact on how they function. He explained that CO_2 interacts very strongly with the water cycle and water limitations and acts strongly with disturbance – particularly fire and increased CO_2 levels will change everything about the way ecosystems work. Increased CO_2 levels result in increased photosynthesis and more carbohydrate production as well as reduced stomatal conductance as plants reduce pore size, become more efficient and lose less water. This often results in increased moisture in the soil. Professor Midgley described how massive carbon storage below ground takes place and with increased CO_2 levels saplings and trees can become very resilient to browsing by fauna, and to fire, and together with increased plant water use efficiency, there are reduced constraints on growth, resulting in super plants and trees. There is evidence that trees grow massive thorns at high CO_2 levels and this impacts the browsers with the plants increased defence system.

Professor Midgley indicated how one of the outcomes of this "shock" to the ecosystem is that woody biomass is increasing in savannah ecosystems and that there is a mass increase of trees. He showed photos taken over the last century in the Eastern Cape which display a major shift from grassy plains to trees in the savannah ecosystems.

Back to the Future? In closing, Prof Midgley highlighted that rising CO_2 is returning the atmosphere to a state not seen on the earth for more than 10 million years and woody plants are a major beneficiary of this change. He expressed the view that we need a new paradigm for conservation under climate change and can no longer rely on passive approaches such as corridor design for species-focused conservation under climate change. Furthermore we need to manage actively for a desired state – grazing/ browsing/fire/ biomass energy. Prof Midgley's final comment to the audience was that this is an exciting time to be an ecologist because things are changing so rapidly.

Dark side of the Universe conference

In November 2014 230 scientists from all over the world converged on Cape Town to attend the 2015 "Dark Side of the Universe" Conference (DSU2015), organised under the guidance of **Professor Peter Dunsby** from the Department of Mathematics & Applied Mathematics, and formally opened by UCT's Vice Chancellor Dr Max Price. The meeting was an immense success, with more than 100 talks covering Dark matter searches, Dark Energy, simulations of the formation of large scale stricture and modifications to General Relativity. This was the 10th in a series of international DSU conferences, the first taking place in Seoul in 2005. Since then this meeting has made its way around the world, touching down in Madrid (2006), Minnesota (2007), Cairo (2008), Melbourne (2009), Leon (2010), Beijing (2011), Buzios, Rio de Janeiro (2012) and Trieste (2013). At the Trieste Meeting, it was decided that DSU2015 should be hosted in Southern Africa and the Astrophysics, Cosmology and Gravity Centre at the University of Cape Town was chosen to host the event.

The series of DSU conferences emanated from the

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EVENTS IN THE FACULTY

recognition in 1998 that contrary to popular belief at the time that the expansion of the universe was slowing, new data from type 1a supernovae suggested that it was in fact accelerating. The problem with this interpretation was that ordinary matter (with positive density and pressure) cannot do this, so some new form of matter with negative pressure (known as “Dark Energy”) was proposed to be dominating the expansion history today. The nature of Dark Energy is without doubt the most puzzling mystery in Cosmology and Astrophysics today, and finding an answer to what it is (or isn’t) is one of the Holy Grails of theoretical Cosmology. Part of the mystery is that astronomers and cosmologists really do not have any clue what it is or whether we will even be able to find an answer to this deep fundamental question. The series of DSU conferences bring together leading researchers in the fields of Astrophysics and Cosmology to address this fundamental question, plus the many intriguing facts and open questions that still require explanation, the most important question of them all is…”What the heck is the ‘Matter’ with the Universe?”.

Apart from the technical workshops, there were two outreach events during the week – a public lecture by Thebe Medupe on African Astronomy and a panel debate on the Dark Side of the Universe, hosted at the University of the Western Cape. Delegates were treated to a tour of the peninsula and a hike to the top of Lion’s Head.

There is no doubt that DSU2015 will have a lasting impact on Astrophysics and Cosmology at the University of Cape Town. For many of the delegates, this was the first time they had visited South Africa and they were impressed by the quality of the science done at UCT, our world class facilities and most of all the excellent young researchers we are producing.

Winter School

Winter School students gathered (left) and on board the Agulhas II

The second annual Science Faculty Winter School for first year science students was held during the July vacation, in the form of a residential school, based on the campus of Bishops Diocesan College in Rondebosch. Around 50 students attended, most of whom had completed just one semester in the Science Faculty at UCT.

The Assistant Dean, Associate Professor David Gammon, initiator and organizer of the Winter School, explained that the concept of a Winter School was developed with the aim of addressing a few interconnected factors common to the first year experience in the Sciences, such as limited knowledge or experience of the range of options open to students having encountered relatively few role-models of working scientists, and that they consequently struggle to find inspiration and motivation in their studies.

Drawing on the wealth of expertise in the Faculty of Science, a series of talks, excursions, discussions and debates, was arranged in the greater Cape Town region. The students visited some of the major instrument facilities at UCT, such as the Scanning Electron Microscope, and the new 600MHz nuclear magnetic resonance spectrometer, to gain insight into how scientists look below the threshold of vision. The excursions were a highlight for many and included a morning spent on South Africa’s research ship, Agulhas II, moored at the Waterfront, under expert guidance of UCT oceanographer Dr Isabelle Ansorge; a visit to the Fossil Park at Langebaan to see the active stone-age dig and fossil evidence for existence of bears and short-necked giraffes. Interspersed between all of this were sessions where students worked on mathematics, physics, chemistry and statistics that they would encounter in the first two weeks of the new semester – to try to get ahead of the game, and also an evening session on “thinking about thinking” and how to re-evaluate their approach to their own studies. The week finished with an excellent gala dinner, addressed by an inspiring UCT BSc (Hons) graduate, Lerato Thakoli, who came through the GEPS (extended) degree programme in the Science Faculty, and described her journey through struggle and then success in her BSc degree, and on to following her passions in a research MSc in Environmental & Geographical Science, looking at land tenure and community issues in trans-frontier parks. The students appreciated her sparkling warmth, passion for science, and the role model she provides of succeeding

SCIENCE FACULTY OUTREACH

against considerable odds.

International Mathematics Olympiad

Emeritus Professor John Webb from the Department of Mathematics and Applied Mathematics was instrumental in bringing the International Mathematics Olympiad to Cape Town and South Africa on behalf of the South African Mathematical Society. After many logistical challenges, including sponsorship, visas and accommodation, the event was attended by 101 countries and 560 contestants. Since this was the first IMO under African skies, special efforts were made to increase African participation. Although not a UCT or Science Faculty event, many in the Department of Mathematics & Applied Mathematics were involved in assisting in various ways.

The Opening Ceremony took place in Jameson Hall and guests were greeted on the plaza by stilt walkers and a marimba band. The IMO contest the following two days took place in the (breezily cold) UCT Sports Centre.

The IMO papers are a marathon 4 1/2 hours long, but all ran smoothly. The participants then enjoyed three days of excursions to Cape Point, Boulders beach and the Waterfront.

A special programme of lectures by world-renowned mathematicians such as Professor Gunther Ziegler (Free University of Berlin), Professor John Barrow (University of Cambridge) and Professor Peter Sarnak (Princeton University) was presented. This was followed by an afternoon of African games, music and dance with the three celebrity lecturers joining in the fun.

Biological Sciences, Oceanography and Marine Research Institute (Ma-Re) Outreach Programmes

In 2014, the Ma-Re Institute together with the Department of Biological Sciences, the Department of Oceanography and the Department of Physics hosted 10 schools (415 learners) in its outreach and education programmes. These programmes were interactive, hands-on presentations and activities that were geared toward getting learners interested in science and marine science and considering careers in marine science.

An additional 15 scholars from a range of schools and grades were hosted by Ma-Re for job shadows, during which time they were given the opportunity to join Ma-Re students on field trips and aboard the new Ma-Re vessel.

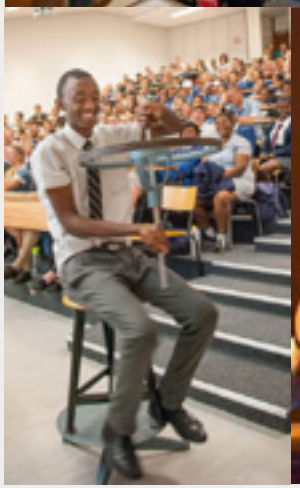
Ma-Re took part in the Annual Sci-Fest Africa event, and their stand was visited by over 9000 learners during the week-long festival. A record-breaking number of 68000 learners attended the festival according to festival hosts.

SCIENCE FACULTY OUTREACH

Phenomenal Physics

Hundreds of Grade 11 Physical Science pupils from a wide variety of local schools were entertained, amazed, challenged and amused by a team of Physics staff during three hours of the Phenomenal Physics programme. The Physics Department's annual flagship schools outreach event, organised by Dr Spencer Wheaton, once again succeeded admirably in provoking thought, eliciting enthusiastic participation and convincing many pupils of the benefits of a science degree, specifically at the University of Cape Town.

Objects (and occasionally the pupils themselves!) were made to swing, sing, rotate, and inflate; jump, bump, chill and sit still; glow, flow, stop and drop. And then there were things that balanced, disappeared, floated on air, burst into flame, or took off over the roof outside. Careful thought went into each presentation, and the learners were encouraged to participate by predicting outcomes and explaining unexpected results.



KEEP CONNECTED – STAY IN TOUCH – KEEP CONNECTED

We value regular contact with our alumni, so please email us on Katherine.wilson@uct.ac.za. We would like to hear about what you are doing with your Science degree in order to enable us to build career profiles of opportunities for Science graduates. We would also like to cover interesting initiatives you are involved in, in future *Contact* newsletters.

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IN MEMORIAM

Professor Gary Marsden, from the Department of Computer Science, died very suddenly on 27th December 2013 at the age of 43. With his passing, the Faculty has lost an exceptional colleague, teacher and friend, who had a huge impact on UCT, ICT4D, the South African and global Computer Science community. Gary constantly strived to make the world a better place through his work and worked hard to be part of the solution, using technology for economic and social empowerment. He was a dedicated and innovative advocate of human computer interaction for development, influential in the development of the profession by focusing on creating technology with people, rather than just for them. Gary cared passionately about his work, his teaching and his students. He was playful, creative and generous and strived to help people learn, make people laugh and empower them through technology. In 2012 Gary was named one of only five academics in South Africa to receive the National Excellence in Teaching and Learning awards, by the Council of Higher Education, as well as being a previous recipient of UCT's Distinguished Teacher Award.

At a memorial service held on campus, moving tributes from staff and students at UCT, as well as international leaders in the field of computer science, hailed Gary as a visionary who understood that the interest of people should inform development of new technology and who cared deeply about the people around him.