

Quest

VOLUME 13 | NUMBER 2 | 2017
ISSN 1729-830X

PLANET EARTH

AN EVOLVING GLOBAL
JIGSAW PUZZLE

Sea squirt city
Port Elizabeth's
tunicate treasure trove



FEATURE

OUR COSMIC
TIME MACHINE



**HOMININ
NEIGHBOURS**

New discoveries at Wits University suggest
that *Homo sapiens* was not alone

ACADEMY OF SCIENCE OF SOUTH AFRICA

The Universe is right next door

The South African Astronomical Observatory (SAAO) brings the Universe closer to home.



We work with leading astronomers and scientists to unwrap the mysteries of the cosmos and continue to play an important role in new discoveries.

We also operate some amazing technologies such as SALT, the biggest optical telescope in the Southern Hemisphere.

If you are thinking of a career in astronomy, the technology behind it or just interested in what goes on in the Universe, why not visit us?

- Tours and visits to SALT and the Cape Town Observatory
- Astronomical information
- Science resources and activities for schools
- Astronomy career information
- In-service technical training
- Scholarships
- National Astrophysics and Space Science Programme



Website: www.saa.ac.za

Telephone: 021 447 0025

Email: enquiries@saa.ac.za

Fax: 021 447 3639

Address: P.O. Box 9, Observatory, 7935
Observatory Road, Observatory, Cape Town



CONTENTS

VOLUME 13 | NUMBER 2 | 2017

COVER STORIES

06 OUR COSMIC TIME MACHINE

Rosalind Skelton explains how SALT is our cosmic time machine

14 A GLOBAL JIGSAW PUZZLE

Geoffrey Grantham and Michael Knoper tell us how our planet is an evolving jigsaw puzzle

34 HOMININ NEIGHBOURS

New discoveries at Wits University suggest that *Homo sapiens* was not alone



13

FEATURES

10 Sea squirt city – Port Elizabeth's tunicate treasure trove

Mike Davies-Coleman, Shirley Parker-Nance and Jodie Watt explain how sea squirts survive in polluted marine environments

18 Bernoulli's Law

Jan Smit and Ashleigh Pieterse explain how one of the fundamental laws of physics is important in our everyday life

22 Astronomy and sustainable development

Karabo Makola shows how development-centred astronomy can lead to sustainable development

30 Midlands magic

Megan Jooste describes the excitement of doing research, with Lize Joubert-van der Merwe

32 Decolonising social sciences

Jess Auerbach shows us what a new university in Africa is doing to decolonise social sciences

NEWS

26 SANSA's Eye in the sky

28 Researchers use 'Fitbits' to track elephant sleep in the wild

29 A kiss of death – mammals were the first to produce venom

REGULARS

39 Books

40 Back page science

41 Maths puzzle

42 Subscription



16



34

Editor

Dr Bridget Farham

Editorial Board

Roseanne Diab (EO: ASSAf) (Chair)
John Butler-Adam
(South African Journal of Science)
Debra Meyer (University of Johannesburg)
Neil Eddy (Wynberg Boys High School)
Kevin Govender (SAAO)
Himla Soodyall (University of Witwatersrand)
Penny Vinjevald
(Western Cape Education Department)

Correspondence and enquiries

The Editor
PO Box 663, Noordhoek 7979
Tel.: (021) 789 2331
Fax: 0866 718022
e-mail: ugqirha@iafrica.com
e-copies: <http://research.assaf.org.za/>
@QuestSa1 - Twitter
Quest: Science For South Africa - Facebook

Advertising enquiries

Barbara Spence
Avenue Advertising
PO Box 71308
Bryanston 2021
Tel.: (011) 463 7940
Fax: (011) 463 7939
Cell: 082 881 3454
e-mail: barbara@avenue.co.za

Subscription enquiries and back issues

Tsepo Majake
Tel.: (012) 349 6645
e-mail: tsepo@assaf.org.za

Copyright

© 2013 Academy of Science of South Africa



Published by the
Academy of Science of South Africa (ASSAf)
PO Box 72135, Lynnwood Ridge 0040, South Africa

Permissions

Fax: 0866 718022
e-mail: ugqirha@iafrica.com

Subscription rates

(4 issues and postage)

(For other countries, see subscription form)
Individuals/Institutions – R130.00
Students/schoolgoers – R65.00

Design and layout

SUN MeDIA Bloemfontein

Printing

Red-Pencil Group



All material is strictly copyright and all rights are reserved. Reproduction without permission is forbidden. Every care is taken in compiling the contents of this publication, but we assume no responsibility for effects arising therefrom. The views expressed in this magazine are not necessarily those of the publisher.

EDITOR'S NOTE

MARCHING FOR SCIENCE

The March for Science was a series of rallies and marches held in Washington, DC in the United States and in more than 600 cities across the world on Earth Day, 22 April this year. Why did it happen? Probably the main reason is US President Trump's complete denial of climate change as being a result of our activities and so something that we can do something about. The US is one of the main signatories to a number of climate change resolutions passed in the last few years, which are now being overturned by changes in environmental legislation in the USA, taking the country back to the dark days of heavy carbon footprints, which caused the problems in the first place. As well as this, he has cut funding to most of the US government science agencies, putting major research programmes at risk – from those on climate change, to space science and medicine.

But there is more to the 'anti-science' stance that the US government appears to be taking than denial of climate change and it is not confined to the US. Various political events in Europe, such as Britain's decision to leave the European Union and the rise of right wing politics across the West, are in the face of increasing dislike of 'experts' and dismissal of statistics that show anything against a populist approach. A good example is the rising intolerance of immigrants in general and refugees in particular. There is plenty of evidence to show that immigration and diversification improves economies, aids education and leads to innovation and employment – in the form of sound statistics showing the effect of immigrant communities on different countries. But ordinary people are rejecting those statistics, instead believing rousing speeches by politicians saying the immigration is bad.



Anti-science is also evident in the rise of anti-vaccination campaigns in Western countries and in the 'Western' sectors of the developing world, leading to outbreaks of dangerous and easily preventable disease such as measles. Lack of confidence in western medicine generally is another example of anti-science.

So, next time you read something that asks you to reject conventional science ask yourself, 'how did I use science today?' Science is all around us – in the way that we eat, the way we get to school or work, the way that we communicate and the way that we protect our planet.

Enjoy the variety of articles in this issue of *Quest* that show just how interesting, important and above all, exciting, science is.

Bridget Farham
Editor – QUEST:
Science for South Africa



BECOME A SCIENTIST



Change the world! Ok, too much pressure! But scientists do change the way we live and understand our world.

Will you be the next leading banker?

What is BIG DATA?

Can we cure the big diseases?

What is Materials Science?

Is it possible to develop a South African solution to clean water and energy?

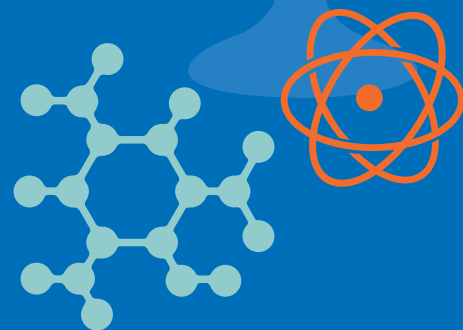
Do you want to be a top researcher in the field of Astronomy and Astro-physics?

Is nuclear energy safe?

Can the environment be saved?

Why is Mathematics important?

Would you like to join a leading Actuarial Science programme?



Choose from an exciting mix of cutting-edge degrees at Wits

www.wits.ac.za/science

Find out more

UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG



Our cosmic time machine

Rosalind Skelton explains how SALT is our cosmic time machine

On a clear dark night, the view of the night sky from Sutherland is spectacular. An arch of light known as the Milky Way stretches overhead. This is the light from thousands of stars in our galaxy, seen from our unique perspective within the galaxy's stellar disk. Our Milky Way is a spiral galaxy that contains billions of stars like the Sun, as well as gas, dust and an unknown substance that doesn't produce any light of its own, simply called 'dark matter'. From our vantage point in the Southern Hemisphere, the Magellanic Clouds, our two nearest neighbouring galaxies, are also prominent features of the night sky. Each of these small companions to the Milky Way has millions of stars. Andromeda, a large spiral galaxy not dissimilar to our own galaxy, may just be visible to the naked eye, although it's much harder to see. With binoculars or a telescope, the Universe beyond the Milky Way opens even further to us. The deeper we look in any direction, the more galaxies we see.

OBSERVING GALAXIES

It wasn't until 1923 that astronomers realised that many of the fuzzy objects they saw through their telescopes were other galaxies outside of our own galaxy, and began to understand what galaxies really are. Measuring distances to far-away objects like stars and nebulae (as galaxies were then known) was a challenging task for astronomers of the early 20th century. The large uncertainties in the measurements lead to heated debates on the size of the Milky Way, which at that

time was thought to make up the whole Universe. With the first definitive measure of the distance to Andromeda made by Edwin Hubble, it became clear that there were objects much further away than the Milky Way was big, and suddenly the Universe had vastly expanded to human eyes. Today we have the technology to observe very distant galaxies in detail using telescopes like the Southern African Large Telescope (SALT). Astronomers use the collected data, often interpreted together with computer simulations, to unravel how the wide variety of galaxies we see formed and evolved.



A nearby galaxy, NGC 613, observed with SALT on 22 September 2016. The bright white/blueish star at the edge of the upper spiral arm, above the yellow nucleus of the galaxy, is a new supernova that was discovered by the 'All Sky Automated Survey for SuperNovae' using a small telescope in Chile the previous night. The prompt follow-up by SALT confirmed what type of supernova it is. It will slowly fade away again over the next few months. NGC 613 is a spiral disk galaxy located about 68 million light-years from Earth in the constellation of Sculptor. The image was made by combining three short images taken with the SALTICAM camera. Image by Vaisanen/van Wyk (SALT)

THE ORIGINS OF THE UNIVERSE

Observations of galaxies are interpreted within a cosmological framework, that is, a theory for the origin and evolution of the Universe as a whole. Our current understanding is that the Universe is expanding, having started out in a very hot, dense phase at the beginning of time, the Big Bang. Tiny fluctuations in the distribution of matter in the early Universe caused some regions to be slightly denser than others. Where there is more mass, there is a stronger gravitational pull, so these overdensities attracted even more material, drawing together more and more dark matter and gas into clumps. Larger structures formed as these clumps collided and merged together under the influence of gravity. Within the densest parts of these structures, gas began to cool down and collapse together to form stars, the seeds of the galaxies we see today. Over time, as gravity continued to pull matter together, groups and clusters consisting of tens or even hundreds of galaxies formed. The galaxies themselves grew by pulling in fresh gas, material for new stars, from the cosmic web and by merging with other galaxies. As two merging galaxies spiral together to eventually form a single larger galaxy, their shapes are distorted and streams of stars are flung far beyond their original disks. Many of the curiously shaped galaxies we observe are probably mergers, caught in the act. Our own galaxy is no stranger to this process – streams of stars found in its outer reaches show that we have cannibalised many dwarf galaxies in the past, and the same fate awaits the Magellanic clouds. Over the next few billion years we will edge closer to Andromeda before eventually colliding with it to become one massive galaxy. The story of galaxy formation is then



Examples of merging galaxies taken by the Hubble Space Telescope. The sequence shows pairs of galaxies at different distances from each other, forming a sequence that shows how the different stages of a galaxy merger could look.

Mergers are probably responsible for the unusual shapes of many of the peculiar galaxies we observe.

NASA, ESA, the Hubble Heritage Team (STScI/AURA)-ESA/Hubble Collaboration and A. Evans (University of Virginia, Charlottesville/NRAO/Stony Brook University) K. Noll (STScI), and J. Westphal (Caltech)

largely a story of gravity counteracting the expansion of space itself.

Dark matter is a key ingredient in this process. Like seeing only the tip of an iceberg above water, there is much more to every galaxy than the light we see. Most of the mass in galaxies does not emit any radiation so we infer its presence from its gravitational signatures rather than any direct evidence. Because dark matter is only affected by gravity, and we have a good understanding of how gravity works, we can straightforwardly simulate how the Universe would evolve with dark matter alone, but adding gas adds huge complexity to the physics. As stars evolve, they clear material from their surroundings through powerful winds and supernovae explosions. Gas may be driven completely out of the galaxy, where it can no longer form new stars. Active black holes at the centres of galaxies also produce vast amounts of energy that may affect the gas throughout the galaxy. Galaxies in highly populated areas are likely to have a very different history to isolated galaxies. They are affected by the tidal forces of the galaxies nearby, and by the hot gas that surrounds galaxies in large groups. To form a complete picture of galaxy evolution, then, we need to explore all of these aspects, from star formation and black holes to galaxy mergers and the largest structures in the Universe. Although that sounds like a daunting task, astronomers aren't easily deterred by problems on an enormous scale!

SPECTROSCOPY

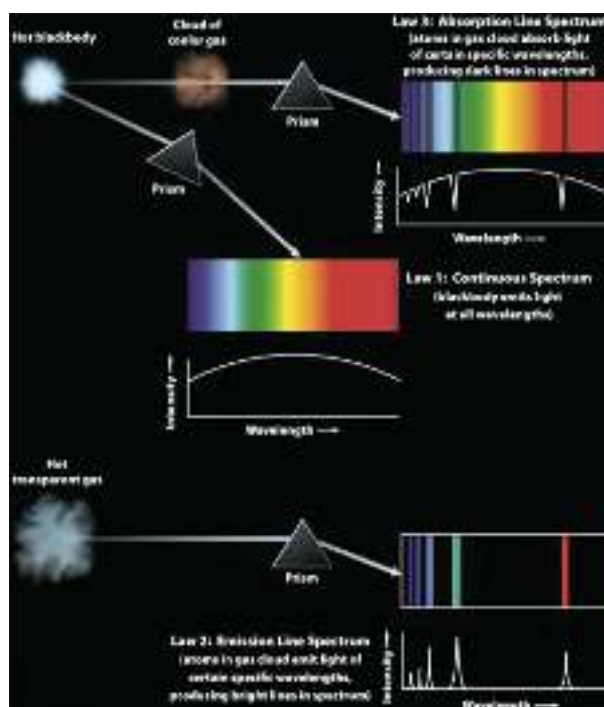
As light does not travel infinitely fast, it takes time to travel from where it's emitted to where we receive it on Earth. The further away the object is, the longer this takes. Although nearby in cosmic terms, light from Andromeda takes 2.5 million light years to reach us, for example. When we look at Andromeda, we don't see

what it looks like today, but rather what it looked like when the light was emitted, 2.5 million years ago. Because we observe galaxies at different distances from us as they were at different times, we can piece together how populations of galaxies have changed over time, like ordering random snapshots of people of all ages to figure out how humans mature from babies to adults. Light we capture with telescopes like SALT today may have been produced very early on in the Universe's history, allowing us to travel back in time from right here in South Africa's Karoo to explore the history of our Cosmos.

The two main observational techniques we use in optical and near infrared astronomy are imaging and spectroscopy. We photograph the sky with very long exposures to record the light coming from distant galaxies and other objects. The bigger the mirror of our telescope, the more light we are able to collect. SALT's 11-m mirror, the largest in the Southern Hemisphere, makes it very efficient for

observing faint objects. We use images of galaxies to measure how much light they emit, study their shape and structure, and look for surrounding objects that might have influenced how they formed. With images of galaxies we are only able to see two dimensions, however. Spectroscopy is crucial for providing the third, allowing us to measure distances to astronomical objects and motion. When we do spectroscopy, the light passes through an instrument called a spectrograph before reaching the camera, separating it out into its different wavelengths, just like a prism of glass produces a rainbow when white light passes through it. Rather than an image of the object, we record a spectrum, which provides powerful additional information, allowing us to measure how much light comes from different parts of the electromagnetic spectrum. Even with SALT's large mirror, we usually need to observe distant galaxies for an hour or more to receive enough light across the whole spectrum.

The principle of spectroscopy. Light is dispersed by passing it through a prism inside a spectrograph. Depending on the temperature and makeup of the star or the gas emitting the light, and gas in the foreground, we see emission or absorption lines at specific wavelengths. These signatures of the elements allow us to determine the composition of astronomical objects, while shifts in the wavelengths tell us about the motion of the object. *WH Freeman and Company*



The main instrument used for observing galaxies on SALT is the Robert Stobie Spectrograph (RSS), which disperses optical or visible light from about 400 to 800 nanometers. This is the part of the electromagnetic spectrum that our eyes are sensitive to, because stars like our sun produce most of their light in this range. At these wavelengths we find many interesting features in the spectra of stars and galaxies, produced by the elements in the stars or by intervening gas. Gas in front of the source of light may absorb radiation at particular wavelengths, causing a drop in the amount of light we receive (an absorption line in the spectrum), while at other wavelengths we might see an excess of light (an emission line). The light we receive from a galaxy is the combined light of all its stars. By looking at the features in a galaxy's spectrum we can infer what kind of stars are in it and how old they are, but importantly, the spectrum also allows us to measure the distance to the galaxy by precisely measuring the wavelengths of the spectral features and comparing them to the expected wavelengths from laboratory measurements on Earth. The difference between the two tells us how long the light has taken to reach us and hence how far away the galaxy is.

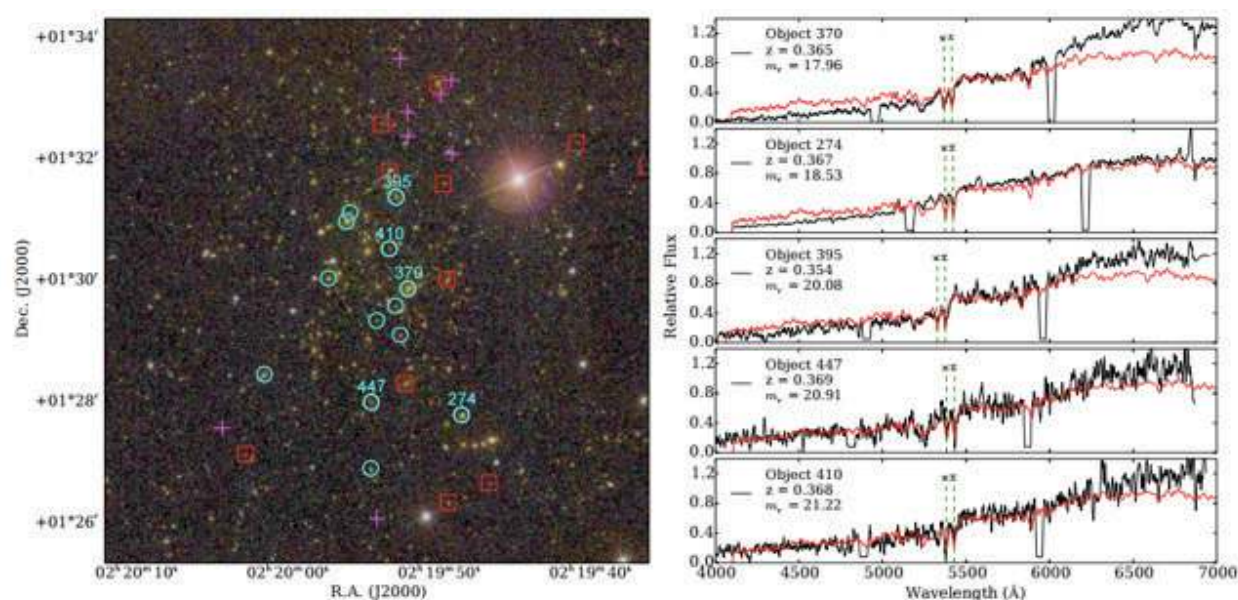
Just as the distance measurement of Andromeda was essential for the

breakthrough in our understanding of galaxies back in the 1920s, the first step to interpreting data on distant galaxies today is to estimate how far away they are. Unless one knows how intrinsically luminous something is, it can be difficult to tell whether it is faint and nearby or far away but bright. Similarly, it is hard to tell how big an object is when you don't know how far away it is. Once we know the distance to a galaxy, we can figure out its true brightness and size, which allows us to infer many of its other characteristics. Knowing the properties of galaxies at different distances, we can then put together a timeline for how they have evolved.

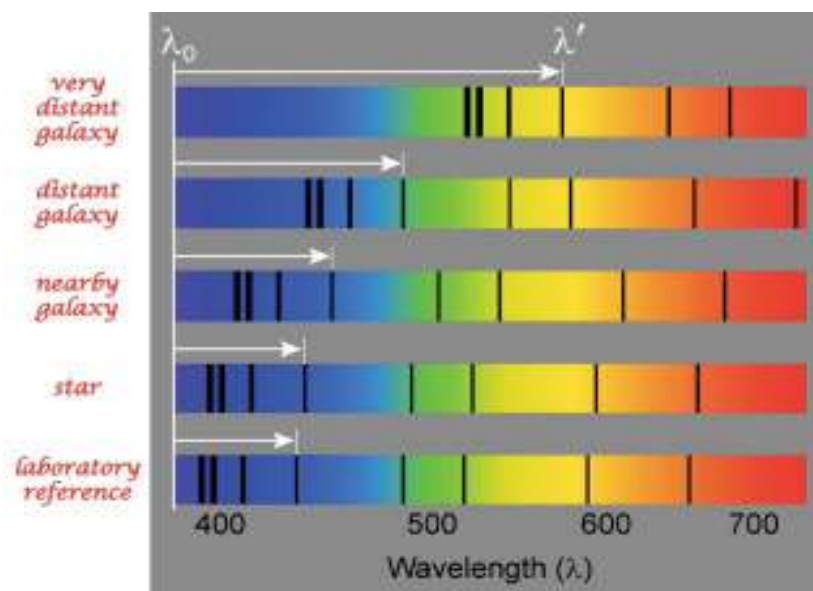
The most distant objects that SALT observes are called quasars, active black holes at the centres of galaxies that release so much energy that we can see them more than 10 billion years later. Quasars often completely outshine their host galaxies, so we see only the point of light coming from the centre. The most distant galaxies we can see with SALT are about 7 billion years in look-back time from us. SALT's very efficient 'multi-object spectroscopy' mode can be used to obtain spectra for about 20 galaxies at the same time, which is particularly useful for measuring the distances to multiple galaxies in a group or cluster. The distance measurements

tell us whether the galaxies are all part of the same group, rather than in the foreground or background. One such project, led by scientists at the University of KwaZulu-Natal, confirmed that there are rich clusters already in the process of forming when the Universe was less than half its age. SALT is also used to observe close pairs of galaxies out to these very large distances, to figure out if they are likely to merge together. Here again, the third dimension is essential. With these measurements we obtain a better understanding of how common mergers were in the past and how they have affected the galaxies involved. These very distant galaxies appear only as tiny fuzzy blobs in our images, but the observations nevertheless tell us a great deal.

When we look at more nearby galaxies, we start to resolve the structure within them. We measure how the stars move within a galaxy, rather than the motion of the whole galaxy, and see how the populations of stars differ from one part of the galaxy to another, rather than estimating average properties of all the stars. These detailed studies of individual systems complement the statistical approach of tracking how many galaxies change over time. With this wide range of galaxy observations from SALT, we are filling in crucial pieces of the puzzle of galaxy formation.



A distant cluster of galaxies observed with the multi-object spectroscopic mode on SALT, from the work of Kirk *et al.* (2015). The SALT observations confirm that the galaxies circled in cyan are all members of the cluster, while the objects with red squares are foreground or background galaxies. The right panel shows some examples of the SALT spectra for the cluster galaxies. Each of them has absorption features (labelled 'K', 'H') at similar wavelengths, showing that they are the same distance from earth. Kirk *et al.*, *MNRAS*



As space expands, the galaxies in it move apart, so from our perspective on Earth, distant galaxies are all receding. The speed at which they move away from us is related to their distance from us. This is known as Hubble's Law, after Edwin Hubble's work in the 1920s. Features like absorption lines in the spectra of galaxies, of known wavelength here on Earth, are found to be 'red-shifted', that is at longer, redder wavelengths. By measuring the shift in wavelength we can determine the speed at which the galaxy is moving away from us and therefore estimate its distance to Earth.

JPL/Caltech/Planck

Dr Ros Skelton is an astronomer on the SALT team at the South African Astronomical Observatory (SAAO). After completing her undergraduate and Master's degrees at the University of Cape Town with the National Astrophysics and Space Science Programme, she moved to Germany where she did a PhD on galaxy formation and evolution through the International Max Planck Research School at the University of Heidelberg. For her postdoctoral research at Yale University in the USA she joined a large international team working on a Hubble Space Telescope project called 3D-HST, before returning to South Africa for a postdoctoral fellowship at the SAAO. She explores the history of the Universe by studying populations of distant galaxies, with the aim of understanding how collisions between galaxies affect their evolution.

CURRICULUM CORNER

GRADE 10 PHYSICAL SCIENCES

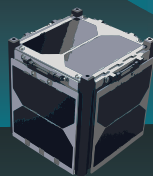
- ▶ Constructive and destructive Interference
- ▶ Infrared Spectroscopy (EM Spectrum)

GRADE 7-9 NATURAL SCIENCES

Radiation of light
Spectrum of visible light – opaque and transparent

create your own future.


Study Electrical and Electronic Engineering at Stellenbosch University.



If you are passionate about technology and the possibilities of tomorrow, studying Electrical & Electronic Engineering at the University of Stellenbosch is for you! Our BEng programme will equip you with a broad knowledge base for a variety of career opportunities, with our graduates in demand in almost every sector of the economy.

Applications for 2018 close on the 30th of June.

Apply at: www.ee.sun.ac.za/apply

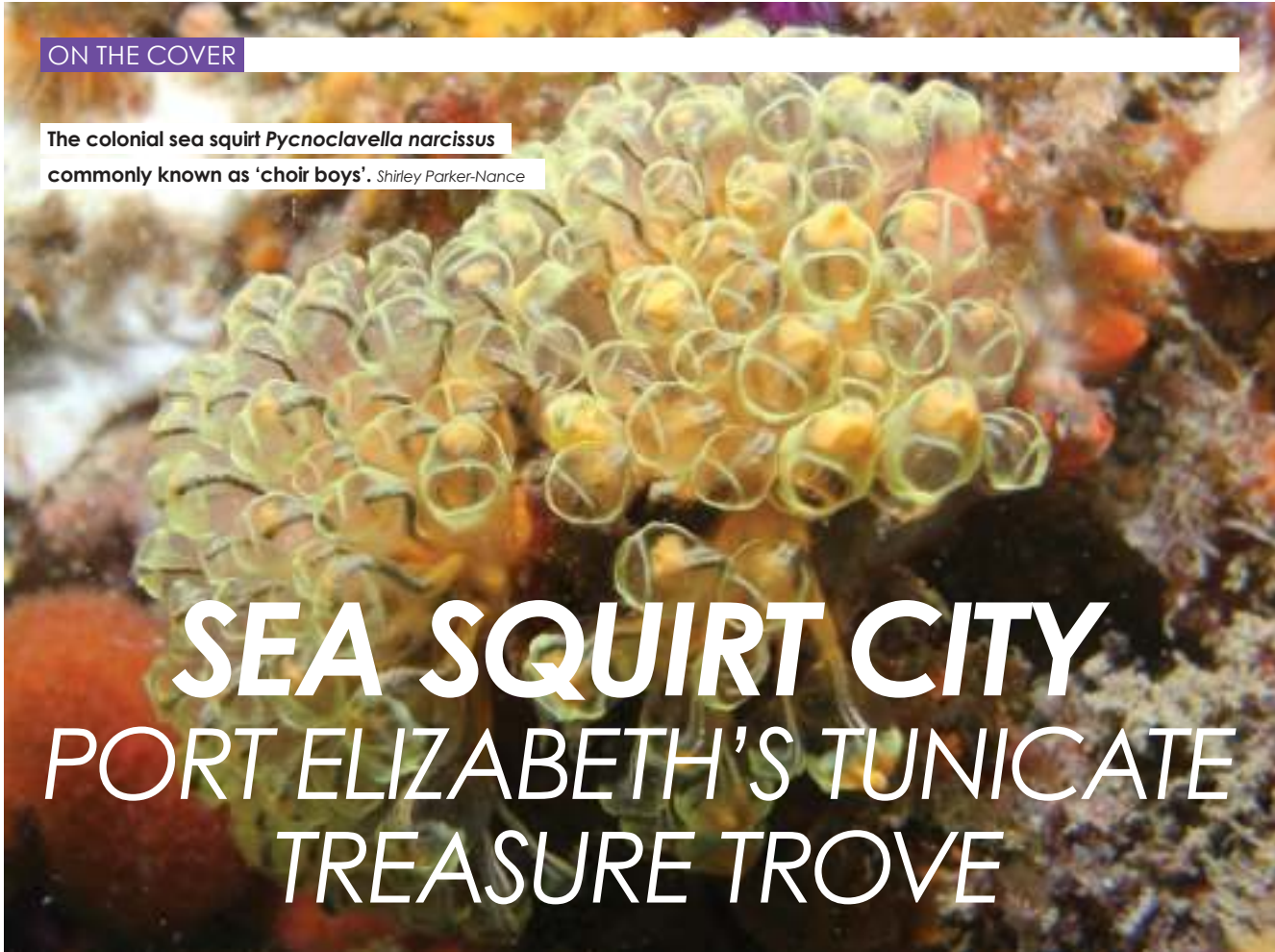
 **ELECTRICAL & ELECTRONIC ENGINEERING**
UNIVERSITY OF STELLENBOSCH
www.ee.sun.ac.za

 facebook.com/eeengsun

 [@ee_eng_sun](https://twitter.com/ee_eng_sun)



UNIVERSITEIT
STELLENBOSCH
UNIVERSITY



ON THE COVER

The colonial sea squirt *Pycnoclavella narcissus*

commonly known as 'choir boys'. Shirley Parker-Nance

SEA SQUIRT CITY

PORT ELIZABETH'S TUNICATE TREASURE TROVE

Mike Davies-Coleman, Shirley Parker-Nance and Jodie Watt explain how sea squirts survive in polluted marine environments

With two bustling ports and a large motor industry, Port Elizabeth is South Africa's fifth biggest city and reputedly the windiest too – not the sort of place that you would expect to find diverse and unique marine life crowding the reefs just offshore. Seemingly unaffected by Port Elizabeth's close proximity, sub-tidal reefs with exotic names like 'Devil's reef' and 'Thunderbolt reef' on the western rim of Algoa Bay, lie only a short boat ride from Port Elizabeth's crowded beaches. Despite having to cope with the constant threat of pollution, regular anchor damage from sheltering fishing boats and unpredictable sea conditions, these inshore reefs are covered with a colourful carpet of marine invertebrates. Large numbers of sea squirt species live alongside delicate soft corals and their medusa-like sea fan cousins, multi-coloured sponges and their attendant sea slugs, sea pens and a galaxy of starfish.

In fact, sea squirts have made up to 40% of the marine invertebrate collected

from this region as part of marine biodiversity studies by researchers at Nelson Mandela Metropolitan University and Rhodes University. These studies have revealed that there are more than 50 known species and at least 80 new species of sea squirts living on the reefs off Port Elizabeth – many of which are thought to be endemic to Algoa Bay.

HOW SEA SQUIRTS SURVIVE POLLUTION

So how does a rather polluted and heavily trafficked bay become home to such a healthy and varied population of sea squirts? It comes down to their ability to survive in polluted marine environments across the globe. Sea squirts are able to concentrate hydrocarbon chemicals and some toxic heavy metals to levels tens of thousands times higher than the surrounding sea water, amazingly with apparently little or no adverse effects to themselves.

This ability might give sea squirts a territorial advantage, enabling them to out-compete other reef filter feeders such as sponges and soft corals that are possibly less able to cope with the inevitable pollution emanating from an industrial city. As filter feeders, sea squirts are capable of filtering vast volumes of seawater – a sea squirt that can fit into the palm of your hand can filter 3 - 4 L of seawater in just under an hour. South African rock and surf anglers may sometimes come into contact with this filtered seawater. If accidentally stood upon, the sea squirt *Pyura stolonifera* (commonly known to anglers as 'red bait') will typically squirt a jet of water from their cloacal or exhalant siphon – hence the name 'sea squirt'.

WHAT IS A SEA SQUIRT?

To the untrained eye, many sea squirts are seemingly similar to sponges in terms of their body shape and ecological

function. So how do you distinguish a sea squirt from a sponge? They are both firmly fixed to the reef and are also both filter feeders sucking in sea water through an oral siphon (sea squirt) or through a series of pores called ostia (sponge), extracting food particles and oxygen from the inhaled sea water and exhaling the clean wastewater through a cloacal siphon in sea squirts or an osculum in sponges. Whereas sponges push the water through an internal maze of interlinked channels, sea squirts pump the water through a distinctive, primitive pharyngeal basket. This basket contains numerous little holes or stigmata lined with cilia that move the water from the interior of the basket to a cavity on the outside of the basket connected to the cloacal opening. The internal surface of the basket is lined with a mucus net secreted by a rod-shaped structure, the endostyle, situated on the side of the basket. The mucus net captures food particles, which are rolled up inside the net like a rope and drawn into a stomach, which forms part of the gut that is ultimately linked to the cloacal or exhalent siphon.

A more technical term for a sea squirt is a tunicate or an ascidian. The



A grey *Pseudodistoma* spp on Philip's reef Algae bay, South Africa.
Shirley Parker-Nance



Four colonial sea squirt species; peach and pink *Didemnum* and a small sandy *Alpidium* colony (middle left margin) and an orange *Symplegma* sp. Shirley Parker-Nance



An intricate colony of the didemnid sea squirt *Trididemnum cerebriforme*. Shirley Parker-Nance

name tunicate comes from the thick tunic of cellulose that protects a sea squirt's internal organs. A sea squirt's tunic contains a simple yet extensive nervous system, which allows the animal to contract its tunic when exposed to sudden changes – either in light, chemical and temperature stimuli or even a diver's touch.

Sea squirts can live in colonies sharing a common tunic (e.g. *Didemnidae* spp) or as solitary individuals (e.g. *Pyura* and *Clavelina* spp). Sea squirt tunics are highly variable and can either be as tough as leather or soft and very fragile; transparent as glass or highly pigmented; drab or brilliantly coloured. Individual members of the colony may either retain their individual oral and cloacal siphons (e.g. *Pseudodistoma africanum* and *Pynoclavella narcissus*) or keep their individual oral siphons and share a common cloacal siphon (e.g. *Aplidium flavolineatum* and *Sycozoa arborescens*). The variations in colonial sea squirt body structure appear to be inexhaustible and are fascinating to observe up close underwater.

SEA SQUIRT CLASSIFICATION AND BIOLOGY

The presence of such an external cellulose body structure (exoskeleton) in an animal is extremely rare and is one of the many unique characteristics that make sea squirts such fascinating animals to study. Interestingly, researchers at the University

of Manchester have shown that very fine slivers of sea squirt tunic (called 'nano-whiskers') can cause human muscle fibres to realign and fuse together, leading to the regeneration of damaged muscles.

The link between sea squirts and humans extends beyond this. The second alternative name for a sea squirt, ascidian, arose from the taxonomic class, Ascidiacea, into which sea squirts were eventually placed by biologists. Where the enigmatic sea squirt actually fits into the animal kingdom has been a challenge for philosophers and scientists since the time of Aristotle. It was only at the end of the 19th century, when the Russian biologist Kowalevsky found similarities between sea squirt larvae and frog tadpoles, that these organisms were placed with some certainty into the new Phylum Protochordata (Class Ascidiacea). The presence of a primitive backbone (notochord) in sea squirt larvae, however, resulted in lively debates for many years around the status of sea squirts as the possible evolutionary link between vertebrates and invertebrates.

Unlike sponges, sea squirts possess simple circulatory systems spread throughout the tunic in addition to their neural system. Adult sea squirts have a simple heart and circulatory system, which completely reverses the flow of the sea squirt's colourless, vanadium enriched 'blood' every few minutes. This is another distinctive sea squirt trait not found in any other animal.

However, it is in their reproductive

biology that sea squirts are the most interesting. Sea squirts are able to reproduce both sexually and asexually – either way, sea squirt adults are simpler animals than their larval offspring, an entirely unique characteristic in the animal kingdom. Once hatched from an egg, the free-swimming, tadpole-like larvae will swim vigorously upwards towards the light. After a few minutes, in possible response to chemical cues produced by adult sea squirts of the same species, the larvae return to the sea bed and settle head first on a suitable vacant surface on the reef.

During development, the larval tail is quickly reabsorbed into the tunic of the developing adult sea squirt. In the process, the animal rotates 90° within the newly forming tunic so that the oral and cloacal siphons point away from the reef towards the surface, thus providing the adult sea squirt with the best opportunity to filter food from the currents passing overhead. All evidence of the larva's notochord is lost in the adult sea squirt. Interestingly, many sea squirt species can also reproduce asexually, in a process

called budding or strobilation. The ability to switch between the two forms of reproduction ensures that sea squirts are able to overcome most reproductive boundaries, and provides them with another competitive advantage in the ongoing battle for the rapid utilisation of available space on a crowded reef.

ANTI-CANCER DRUGS

And just when you thought a simple sea squirt could not possibly be more intriguing, they may also have a role to play in providing us with the next generation of anti-cancer drugs. Sea squirts, in common with many other marine invertebrates, are reservoirs of toxic, organic, small-molecule natural products that are produced either by the sea squirts themselves, or the symbiotic microorganisms that live inside, or on the surface of, sea squirts. Numerous roles have been proposed for these marine natural products, including chemical defence against both invertebrate and vertebrate predators and chemical cues for larval settlement.

A few years ago the anti-cancer drug trabectedin (marketed as Yondelis®), the first drug of its kind in over a decade, was approved for the treatment of cancers of the soft tissues (i.e. muscles, tendons and blood vessels). Originally obtained from the Caribbean sea squirt *Ecteinascidia turbinata*, the initial supplies of trabectedin for clinical trials were obtained from extensive aquaculture of *Ecteinascidia turbinata*. Regrettably, neither sustainable harvest from wild populations nor aquaculture are ever sufficient to meet the annual global demand (1-5 kgs) of a marine natural product derived drug, once that drug is approved for use in treating cancer. Fortunately, using a combination of bacterial fermentation processes and laboratory chemistry the pharmaceutical company Pharmamar was able to bring a synthetic version of this natural anti-cancer compound to market.

The trabectedin story is an important lesson for us all. Who knows what other possible wonder drugs are still awaiting discovery from the many sea squirts living on the unexplored reefs lining Algoa Bay



A solitary yellow *Phallusia* sp. with siphons visible as it protrudes from a crevice. Shirley Parker-Nance

and the rest of Africa's coastline? Recently chemistry researchers from Oregon State University in the USA and Rhodes University in Grahamstown discovered a group of new natural products in very low concentrations (< 1 mg) from an endemic sea squirt, *Lissoclinum* sp., which they named the mandelalides after the Nelson Mandela Metropole which borders Algoa Bay. The complex chemical structure of the mandelalides, coupled with an ability to kill certain cancer cells in an apparently different way to other anti-cancer chemicals, has made these natural products particularly interesting to their discoverers. The success story of trabectidin, and the ongoing excitement around the recent discovery of the mandelalides (see reference), must make us question whether we are doing enough to protect vulnerable marine invertebrate species from extinction before it is too late – before nature's templates for life-saving drugs are lost forever?

The next time you find yourself in Port Elizabeth and about to step on a sea squirt washed up on the beach, take a minute to have a closer look – not only are you gazing upon a vertebrate/invertebrate taxonomic conundrum, you're also looking at a toxic sink for man-made pollutants and a possible cure for cancer. And like us, their tentatively long-lost human relatives, sea squirts undoubtedly fulfill a crucial role in keeping Algoa Bay clean.

Reference:

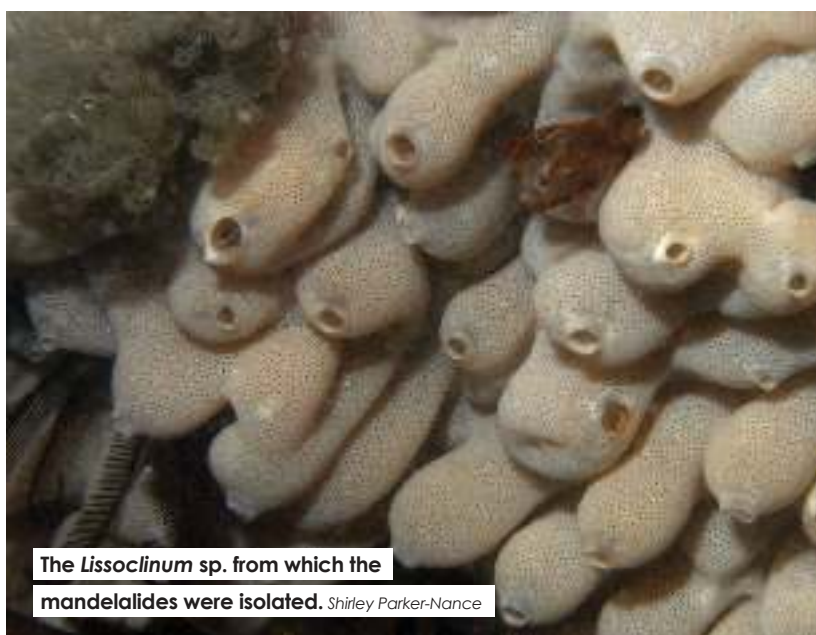
Davies-Coleman, MT, Veale, CGL. 2015 Recent advances in drug discovery from South African marine invertebrates. *Marine Drugs* (13):6366-6383.

Professor Mike Davies-Coleman is a marine natural products chemist and Dean of Natural Sciences at the University of the Western Cape. His daughter, Jodie, is a freelance writer and designer based in Ballito, KwaZulu-Natal. Both father and daughter share a love for the ocean and Africa's wild places and wild life in all its forms. Dr Shirley Parker-Nance is an ascidian taxonomist, accomplished underwater photographer and a recognised expert on the endemic marine invertebrate fauna of Algoa Bay's prolific benthic reef systems. She is based at SAEON Elwandle Coastal Node in Port Elizabeth.



A fan-shaped colonial sea squirt

Sycozoa arborescens. Shirley Parker-Nance



The *Lissoclinum* sp. from which the

mandelalides were isolated. Shirley Parker-Nance

A GLOBAL

Geoffrey Grantham and Michael Knoper tell us how planet Earth is an evolving global jigsaw puzzle

Imagine attempting to piece together a jigsaw puzzle where the shape of some of the pieces is continually changing in time and the detail on some pieces has been hidden or removed. This is the problem facing geologists concerned with the reconstruction of supercontinents which have formed and then broken up during the evolution of the planet Earth. It is now recognised that the evolution of Earth, since its formation ~4 600 Ma (million years) ago, has involved processes that caused the continual formation and breaking up of supercontinents. The most recent of these was Pangaea, which in part consisted of the two very large continental landmasses of Laurentia and Gondwana.

The jigsaw pieces of Gondwana comprised the continents and islands of Africa, Australia, India, Madagascar, Sri Lanka, South America, Falkland Islands and Antarctica (Fig. 1).

GONDWANA – A SUPERCONTINENT

Gondwana formed approximately 550 Ma ago and started breaking up about 200 Ma ago. Gondwana itself is often considered a supercontinent, and our understanding of the configuration of Gondwana is now broadly accepted although definition of the exact fits of the pieces remains hard to define. There are several reasons for this. The margins of some of the continents are locally submerged under the sea; there has been later deposition of younger sediments on some continent margins; younger collisions have resulted in the shapes of some pieces being changed, and parts of some continents

were obscured by collisions between continents. Fortunately, geological processes commonly occur on large scales, effectively limiting the number of significant jigsaw pieces making up Gondwana to less than ten. The precursor supercontinent to Gondwana was Rodinia – identification of the pieces making up Rodinia is still the source of much debate and research. There is geological evidence that suggests that Rodinia was put together about 1 000 Ma ago. This then broke up, starting about 800 to 700 Ma ago, and was followed by the assembly of Gondwana from various continental fragments between 700 and 550 Ma ago during the Proterozoic eon.

Proterozoic felsic gneiss

Fig. 2. A group of research geologists from the Department of Geology at the University of Johannesburg examining an outcrop of Proterozoic felsic gneiss during the 2016/17 summer field season. M Knoper

PROTEROZOIC EON

This is the younger of the two divisions of Precambrian time – the older is the Archean Eon. The Proterozoic Eon extended from 2.5 billion to 541 million years ago.

RECONSTRUCTING GONDWANA AND RODINIA

Reconstructing the history of the jigsaw pieces of Gondwana and Rodinia is part of the work of researchers in the Department of Geology at the University of Johannesburg who have been involved in mapping the geology in western Dronning Maud Land, Antarctica, intermittently since 1991. Current research is focusing not only on the assembly of Gondwana but also on the breakup of Gondwana (Fig. 2).

In Antarctica, the geologists can see less than 2% of the underlying rock because the remaining 98% is covered by ice, which in some areas, has been found to be more than 4 km thick. The shape of Antarctica is also largely masked by the ice sheet which, in some areas, extends hundreds of kilometres beyond the sea level position of rock, resulting in floating ice shelves. Although the ice cover severely restricts the amount of rock exposed, the rocks, when exposed, are generally fresh, and the age relationships between different rocks types are clear. Even though the areas available for data collection are greatly restricted, the data gathered from such untouched rock exposures are sufficient to permit

At the moment, the north magnetic pole can be found near the Earth's north pole. This is called normal polarity. When the north magnetic pole is found near the Earth's south pole, this is called reverse polarity. We can use this to show how the ocean floor has spread because we can see the polarity of the Earth's magnetic field in rocks, which results in alternating strips of ocean floor showing normal and reversed polarity. As magma cools, particles in it are 'frozen' in the direction of the magnetic field at the time.

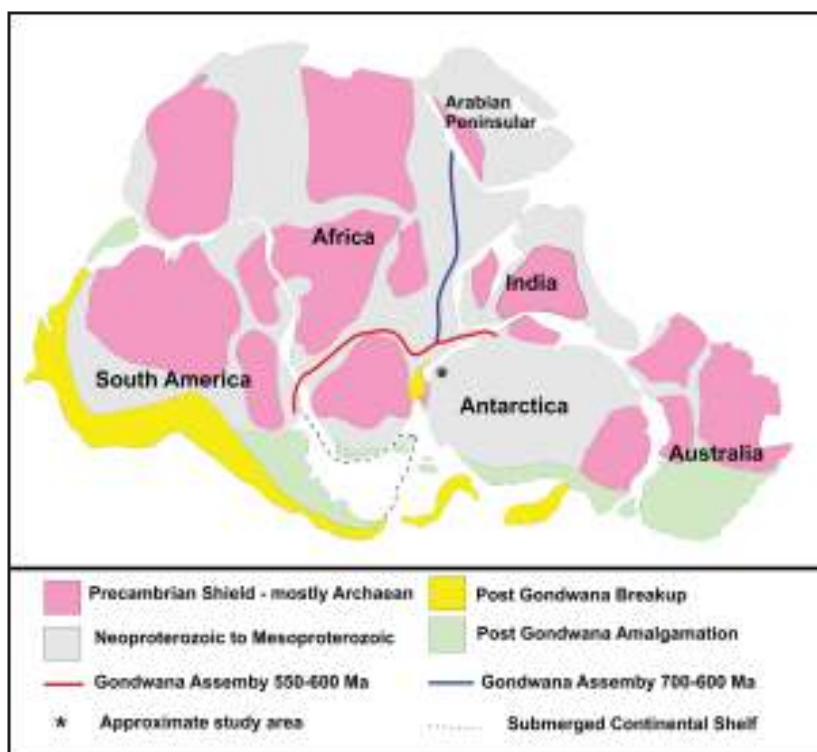


Fig. 1. Hochlinfjellet Mülig-Hofmannfjella. The large landmass of Gondwana, a supercontinent that was in existence for about 350 million years, from 550 to 200 Ma ago. Illustration by G Grantham

comparisons of the geology of western Dronning Maud Land with the geology of southeastern Africa. We know that Antarctica was next to southeastern Africa before the breakup of Gondwana that started about 200 Ma ago.

An important method used in reconstructing the distribution of continents involves studying the magnetic polarity of rocks that formed over time, combined with accurate determinations of the age of such rocks. These studies focus both on volcanic rocks, which form the ocean floors, as well as igneous rocks (volcanic and intrusions) on the continents. The ocean floor studies are particularly valuable when considering the extent of the ocean floor and its continuous growth, because the polarity of the Earth's magnetic field undergoes irregular periodic reversals.

The magnetic polarity as well as the preserved magnetic inclination are faithfully recorded by iron-rich minerals in igneous rocks. The preserved inclination gives information on how far the rock crystallised away from the magnetic pole prevailing at the time. The rocks on the ocean floor are formed continuously by submarine eruptions at 'spreading centres' at rates typically of

4 - 6 cm per year and rarely up to 11 cm per year. These centres are commonly located at (or close to) the middle of the oceans. The rocks produced at these centres display patterns of normal and reversed polarities, which are mirrored symmetrically on both sides of the spreading centres.

AFRICA SPLITS FROM ANTARCTICA

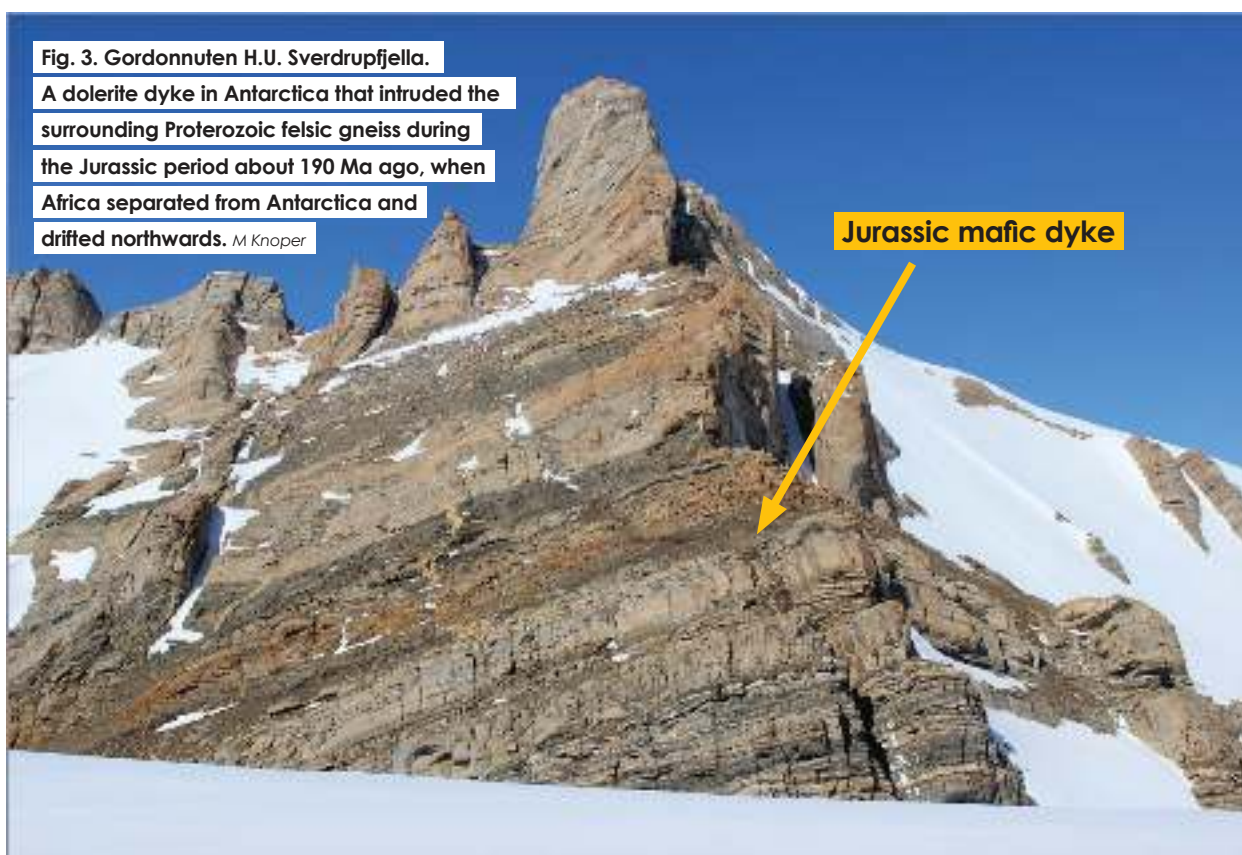
Approximately 190 Ma ago, during the Jurassic period, when it is thought that Africa and Antarctica parted company, the magnetic reversals were undergoing a 'quiet period' which has made it difficult to use the reversed polarity in rocks of that age on the ocean floor. Also, younger

FELSIC GNEISS

Gneiss is a common distributed type of rock formed by high-grade metamorphic processes from pre-existing formations that were originally either igneous or sedimentary rocks. Felsic means that the gneiss contains dominantly light-coloured silicate minerals.

Fig. 3. Gordonnuten H.U. Sverdrupfjella.

A dolerite dyke in Antarctica that intruded the surrounding Proterozoic felsic gneiss during the Jurassic period about 190 Ma ago, when Africa separated from Antarctica and drifted northwards. M Knoper



sediments deposited along continent margins mask the strength of magnetic signals, making it difficult to work out the shape of coastlines at the time of Gondwana breakup. On the continent, rocks formed from the breakup of Gondwana consist of intrusive dykes, large igneous complexes and basaltic lavas. These basaltic lavas are extensions of the basalts that form the Drakensberg mountains in South Africa and Lesotho. If we are to compare rocks of these ages, we need to also study the rocks exposed on land to see if their distributions

and geological histories might help us to work out how the continent of Gondwana looked.

Part of the current research is studying the age, chemistry and paleomagnetic signatures of the dykes (Fig. 3). Much is known about these rocks on other continents, but because Antarctica is so remote and difficult to get to, there is limited information on similar rocks on that continent. This is one of the main parts of our research.

There is a 'belt' of rocks that extends from the west coast in Namaqualand to the east coast of Natal in South Africa, continued through western Dronning Maud Land, Antarctica and northward into Mozambique and eastwards through Sri Lanka and probably back into eastern Dronning Maud Land. These rocks have been dated at between 1 000 and 1 200 Ma old and are thought to have contributed to the formation of the supercontinent of Rodinia. In addition, some of the rocks in the belt have been made of the types of rock that are typical of the edge of continents or the margins of continental plates. This suggests that the block comprising at least most of southern Africa, most of Antarctica, Australia and part of Sri Lanka was not fragmented

during the breakup of Rodinia ~700 – 800 Ma. This suggests that this grouping of parts of these continental blocks remained as a unit or jigsaw piece which formed part of Rodinia.

Geoffrey Grantham completed his PhD studies at the University of Natal on the geology of part of western Dronning Maud Land in 1993. After lecturing at the University of Pretoria for about 10 years and working at the Council for Geoscience for about 17 years he moved to the University of Johannesburg to continue research into the geological evolution of southern Africa, Antarctica and other fragments of Gondwana. He has had 12 field seasons in Antarctica, as well as doing extensive field work in Namaqualand, Natal and Mozambique.

Michael Knoper studied at the University of Washington in Seattle (USA). He has lectured at the University of Johannesburg since it was established in 2004. When he isn't busy with lectures, Mike's research is focused on the evolution of the continental crust, the assembly and breakup of supercontinents through geological time, and the occurrence of ore deposits. He first went to Antarctica as a member of the South African National Antarctic Programme in 1992 to map the geology of the Kirwanveggen.

DEFINITIONS

Dyke: a type of later typically vertical rock intruding older rock.

Igneous complex: A large intrusion of igneous rocks with varying rock types, which has crystallised and forms a complex structure, frequently with layering.

Basaltic lava: this is molten rock that is enriched in iron and magnesium and low in silica – when it cools on the Earth's surface it forms basalt.

An Antarctic field camp. M Knoper



WALTER SISULU UNIVERSITY



Accredited diplomas, degrees and postgraduate studies

WSU offers fully accredited diplomas, degrees and postgraduate studies in a wide range of health and science programmes such as:

MBChB; B Cur (Basic); Bachelor of Medical Sciences (Physiology, Biochemistry or Microbiology); Bachelor of Medical Clinical Practice; Bachelor of Social Work; Bachelor of Science in Health Promotion; Chemistry & Chemical Technology, Environmental Sciences, Physics, Biological Sciences (Pest Management), Botany, Zoology, Information Technology & Computer Science, Engineering - Civil, Electrical, Mechanical, Construction Management & Quantity Surveying, Applied Statistical Science, Mathematics, Consumer Science: Food & Nutrition as well as technological programmes in Fashion and Art.

For more information:

Tel: 047 502 2111/2844 (Mthatha)
Tel: 043 708 5200 (Buffalo City)
Offered at Buffalo City (East London),
Butterworth and Mthatha Campuses.

For affordable, fully accredited, quality higher education contact us today and apply before 30 September.



www.wsu.ac.za

A developmental university... • technological • scientific • innovative • responsive

2017 17

WSU
Walter Sisulu University

Bernoulli's Law

Jan Smit and Ashleigh Pieterse explain how one of the fundamental laws of physics is important in our everyday life

Daniel Bernoulli came from the famous Bernoulli family. He was an able mathematician and physicist. We remember Bernoulli for his famous law of physics, in everyday language known as Bernoulli's Law. What does this law say and where is it applicable?

BERNOULLI'S LAW

To explain this law let's start with a very simple example. Bernoulli's Law states that where a gas such as air flows *fast* the pressure is *low* and where the gas flows *slowly* the pressure is *high*. It is easy to remember Bernoulli's Law.

Slow flow – high pressure, fast flow – low pressure.

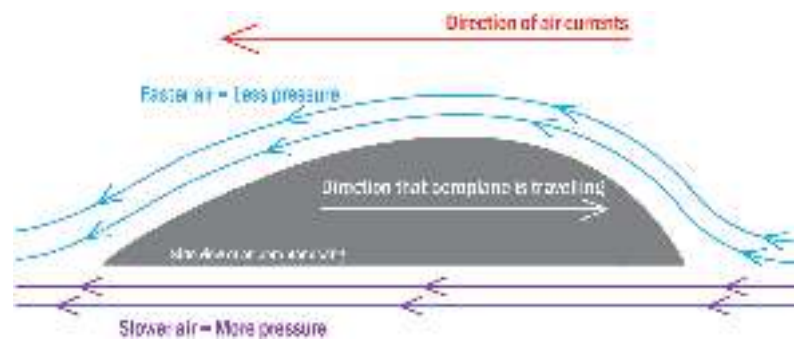
Let's look at applications of Bernoulli's Law. Consider a cross-section through an aeroplane wing. The top is curved (has a hump). The lower side is flat.

When air passes over the wing it flows fast and the pressure is low.

At the lower flat side of the wing air flows more slowly and the pressure is high according to Bernoulli's Law. The result is that the higher pressure at the lower end pushes the wing upwards. This pressure difference over the entire wing is sufficient to carry the aeroplane, its crew and passengers with their luggage in the air. The pressure difference between the lower and upper sides of the wing is dependent on the speed of the plane. The faster it moves the greater the difference. Later in this article we will give a simple mathematical formula to calculate this difference.

MORE APPLICATIONS OF THE LAW

Bernoulli's Law has many more applications. For example, why does a book page turn by itself in wind from an open door or window? Why does a



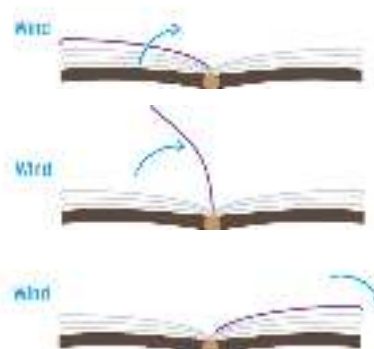
An illustration showing how air flows over an aeroplane wing. North-West University

moving ball change direction? Why does a stove burn better on a windy day? Why are house roofs blown off in strong winds? And finally, how does the creepy crawly move around a swimming pool?

Let's answer these questions.

► Why does a page turn by itself?

According to Bernoulli the pressure is low where air moves fast. If you are studying and a book lies open on the table in front of you and wind blows from an open door or window over the book the pressure over the top page is low and between the pages where there is no wind the pressure is high. The high pressure then pushes the page up and the pages seem to turn by themselves.

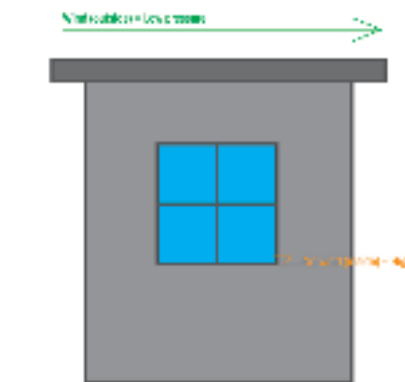


How a page turns in the wind. North-West University

► How does the wind blow a roof off?

Look at a house with a flat roof. On a windy day you close the doors and windows to keep dust and leaves out. This means that inside the house there is little or no movement of air. So, according to Bernoulli the air pressure inside the house is high.

Outside where the wind blows, the pressure is low. It blows fast over the roof. What is the situation now? High pressure inside the house and low pressure outside. As the area of a roof is large, the pressure difference causes a large upward force on the roof. If the roof is not well secured with nails and screws it lifts easily and blows off.



How the wind blows a roof off a house. North-West University

► Why does a stove burn better on a windy day?

We assume that the top of the chimney outside is higher than the rest of the house. Inside the chimney there is no wind and according to Bernoulli, there is high pressure. The outside smoke is blown away by the wind and according to Bernoulli its pressure is low. The air inside then moves up to the lower pressure outside and new fresh air is sucked over the coal or wood in the stove and it burns well.



How the wind makes a stove burn better. North-West University

► How does a creepy crawlly work?

A creepy crawlly is used in a swimming pool to suck up dirt and leaves.

The creepy crawlly consists of a pipe connected to the pool's pump and a soft rubber mouth under water, usually at the bottom. When the pump sucks water through the pipe the pressure inside the pipe is low. Outside the rubber mouth the flow is very slow and according to Bernoulli the pressure is high. The high pressure outside causes the mouth to close and the creepy jumps slightly forwards. The whole process then repeats and the result is that dirt is sucked in with the water going through the pipe to the filters.

It is worth knowing that the creepy crawlly is a South African invention, now used across the world.

These examples illustrate a few of the many applications of Bernoulli's Law.



A creepy crawlly at work.

Original photograph: Ebay. 2017. <http://www.ebay.com.au/itm/Deluxe-Automatic-Swimming-Pool-Cleaner-Above-In-Ground-Large-Leaf-Technology-/162397335847>. Edited by Ashleigh Pieterse.

BERNOULLI'S LAW IN MATHEMATICAL FORM

In simple mathematics the expression for Bernoulli's Law is:

$$\rho v^2 + P = \text{constant}$$

Where:

ρ = the density of the medium e.g. air

v = the velocity of the medium and

P = the pressure in the medium.

From the equation it is clear that if the velocity v increases the pressure P would decrease. More: the pressure decreases with the square of the velocity. If for example v doubles then P would decrease fourfold. This equation makes it clear why the pressure depends so strongly on the velocity of the gas or liquid.

From the above it is clear that Bernoulli's Law can be stated in a *quantitative* and a *qualitative* way. The quantitative way gives a means to calculate the magnitude of the forces involved. Mathematics is involved.

The qualitative way is usually verbal. It provides a way to understand the Law. That is how we explained the aeroplane, creepy crawlly and other applications of Bernoulli's Law.

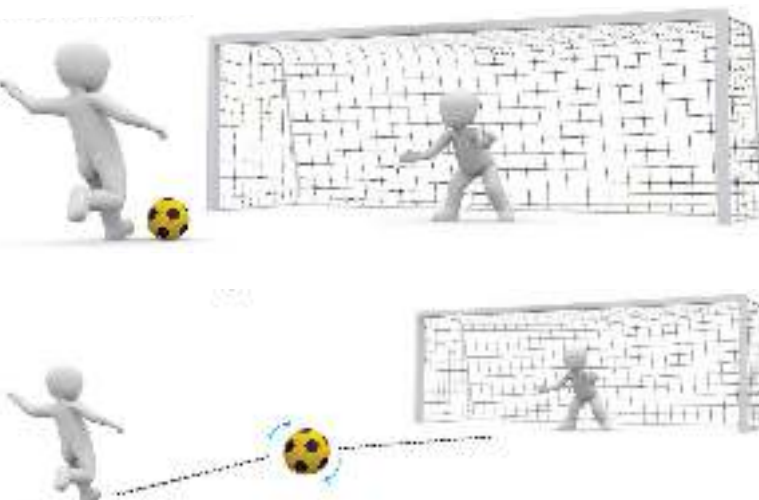
Jan Smit is Manager of the Science Centre at Potchefstroom, North-West University. He holds a DSc in Nuclear Physics.

Ashleigh Pieterse is the Senior Liaison Officer for the Faculty of Natural Sciences, Dean's Office, North-West University, Potchefstroom.

WHY DOES A BALL CURL?

Consider a soccer ball kicked towards the goal keeper. The kicker kicks it in such a way that it rotates. The one side rotates towards the kicker and the other side away from the kicker.

The side rotating towards the kicker tends to pull the air towards the kicker. This results in a higher speed of air on that side. On the other side of the ball the air is pulled towards the direction that the ball moves. This causes lower air velocity. The end result is high pressure of air on one side and low pressure on the other side. The ball then curls in flight towards the low pressure. In soccer, goal keepers are often deceived. They think that the ball will miss the goal but the curl brings it in.



How a soccer ball curves. North-West University

Want to be an engineer?

Keeping the wheels of society turning

Engineering is a broad discipline which involves the design, building, maintenance and development of things – engines, machines and structures – that are needed by humans but that do not exist in the natural world.

Engineering uses science, maths and technology to solve problems by finding the most suitable solution. An important part of engineering involves identifying and understanding the constraints of a design, to enable it to function successfully within these limits.

Quick check:

Is engineering a suitable career for you?

Ask yourself the following questions:

- Are you curious about how things work and do you like to solve problems?
- Do you enjoy working in a team and want to create things that will improve people's lives?
- Do you have an aptitude for Science and Maths?
- If the answers to these questions is a "yes", you should consider a career as an engineer.

FOR EXAMPLE...

GLORIA MOHOLI

Job: Electrical Engineer

Qualifications: BEng (Electrical Engineering);
MSc (Electrical Engineering)

Gloria works in the Sustainability Division of Eskom's Research, Test and Development Unit.

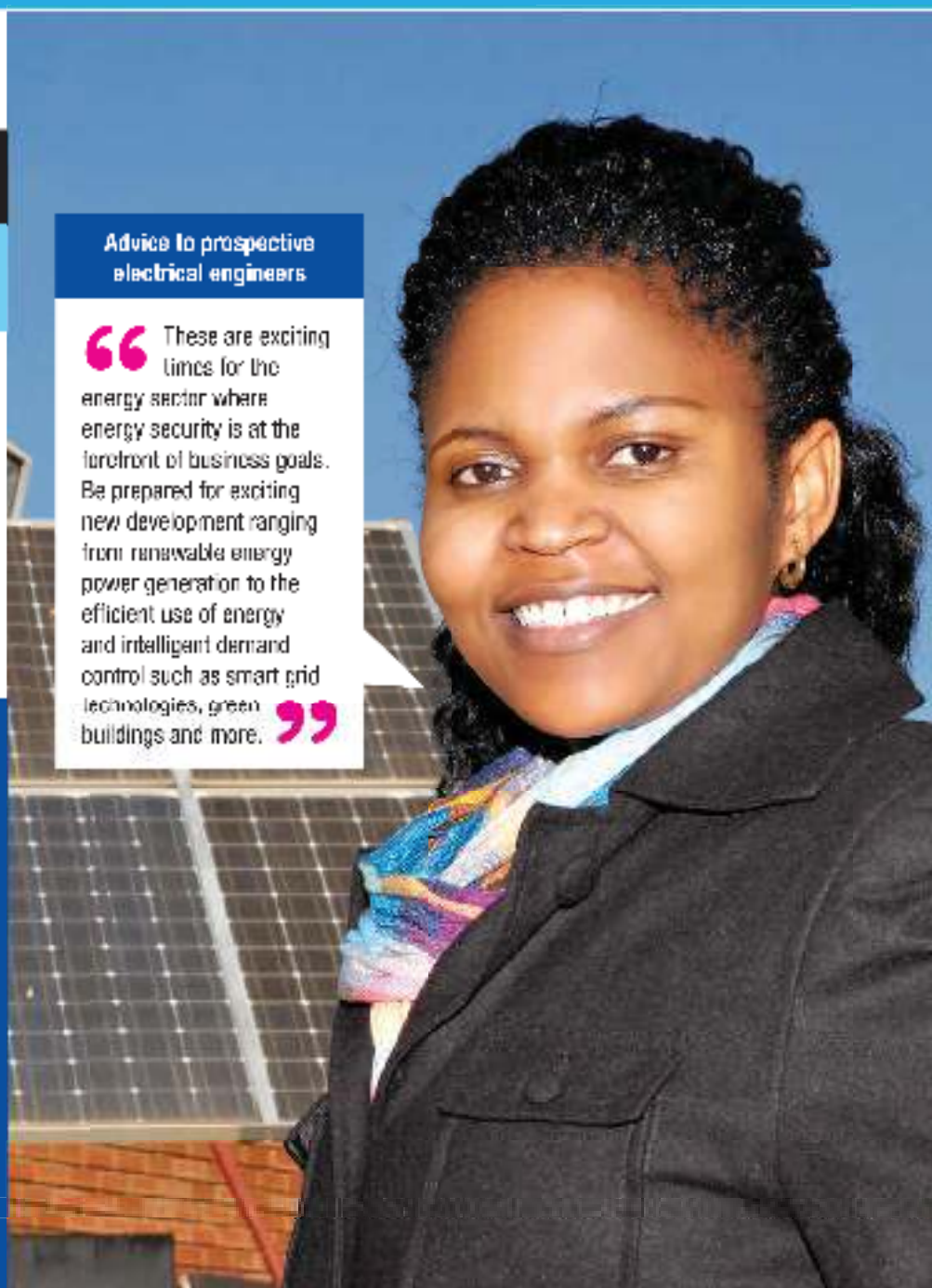
She helps identify, test, demonstrate and advise the relevant sections of Eskom on new and emerging technologies which can be adopted to reduce energy consumption, decrease reliance on coal power and thus reduce Eskom's and the nation's carbon footprint.

How she got there

"I was inspired to study electrical engineering out of sheer curiosity. I wanted to learn more about the technologies and engineering used to generate, transmit and distribute electricity up to the point of consumption. The recent power challenges, combined with environmental issues, further inspired me to study further and learn more about technologies to address them. Playing an innovative role in the development of South Africa's sustainable energy industry into a world class utility is rewarding work."

Advice to prospective electrical engineers

“ These are exciting times for the energy sector where energy security is at the forefront of business goals. Be prepared for exciting new development ranging from renewable energy power generation to the efficient use of energy and intelligent demand control such as smart grid technologies, green buildings and more. ”





SEGOMOTSO KELEFETSWEI

Job: Dam engineer

Qualifications: BSc (Civil Engineering)

What do civil engineers do?

They focus on creating, providing and improving facilities for everyday living, industry and transportation. This includes work on water supply and irrigation systems, dams, water purification plants, storm water systems, flood control structures, sewerage systems, sewage works, harbours, docks, tunnels, canals, bridges, roads, motorways, large buildings, sports stadiums, railways and airports.

Segomotsi works in the Heavy Engineering division of Arcus Gibas, an engineering consulting firm.

His job involves the planning, designing, construction, inspection and maintenance of dams and hydropower schemes. He looks at the scientific aspects of the design, analysis and modelling of dams which require a wide spectrum of engineering knowledge in geology, hydrology, hydraulics, materials and structures, and some interaction with mechanical and electrical engineering. He is currently specialising in materials engineering, with a specific focus on roller compacted concrete.

How he got there

"After completing my studies at the University of the Witwatersrand, I began my career working at the Department of Water Affairs and Forestry, dealing with the monitoring and inspection of dams in terms of dam safety legislation. I then worked as a design engineer for the Raising the Flag Doshielo Dam in Marble Hall. I also did the rehabilitation, maintenance and betterment works involved in the preliminary design and option analysis for the remedial work for Glen Brock Dam in the Eastern Cape.



SAASTA

South African Agency for Science
and Technology Advancement

For more information on careers in science, engineering
and technology and to participate in our role-modelling
projects, please contact SAASTA at:

Email: info@saasta.ac.za | Tel: +27 12 392 9300

Fax: +27 12 320 7803 | www.saasta.co.za

ASTRONOMY & SUSTAINABLE DEVELOPMENT

Karabo Makola shows how development-centred astronomy can lead to sustainable development

ON THE COVER

Most people would think that astronomy is 'just another science discipline', that is only focused on research and propping up or repudiating scientific theories. The International Astronomical Union's (IAU's) Office of Astronomy for Development, however, may prove otherwise. This discipline can also be a development tool that can be used to bridge the knowledge gap between astronomers and laypeople with a focus to inspire and excite them about the wonders of the universe.

Astronomy is a field that combines science and technology with inspiration and excitement. It evokes curiosity about the universe and our place in it. According to the IAU 'It is a discipline that opens our eyes, that gives context to our place in the Universe, and that can reshape how we see the world'. As such, it can play a pivotal role in facilitating education and human

"Astronomy provides an inspirational and unique gateway to technology, science and culture [...] by mobilising large numbers of talented and creative scientists, engineers and teachers in the service of international development. The plan will be a cost-effective spinoff of one of the most profound adventures of our civilisation-the exploration of the Universe."



capital development. The skills related to the field of astronomy can also be used to further sustainable development throughout the world. Astronomy has contributed immensely to knowledge acquisition and to science in general. It can serve as a bridge between the sciences due to its natural interdisciplinary nature.

'KNOWLEDGE DIVIDE': WHAT IS IT?

The 'knowledge divide' exists, just like the concept of the 'digital divide'. The digital divide can be loosely defined as the social and economic inequality in access to information and communication technologies (ICTs) between the elite haves and the impoverished have-nots. There currently exists a huge knowledge divide between astronomers and society. This divide is due to ineffective or lack of communication between the two. Unfortunately, as much as there is a huge divide in access to astronomy between the elite and impoverished communities, it does not necessarily end there. There is a secondary divide between men and women in astronomy. The gender inequality is quite significant, especially in developing countries where you will find few or no female astronomers or scientists generally. The IAU strategic Plan 2010 - 2020 recognises that astronomy is a field that can be used to develop societies across the globe. With this in mind, it maintains that, by using astronomy to educate and inspire societies, positive changes will occur. In other words, the IAU sets out to bridge the knowledge divide as a way of developing societies.

THE INTERNATIONAL ASTRONOMICAL UNION

The IAU is the largest body of professional astronomers across the world. It was founded in 1919 with the goal of advocating and safeguarding the science of astronomy through international cooperation. The IAU has 12 391 members. The individual members'



directory contains 10 175 names in 98 countries worldwide. Of those, 74 countries are National Members. In addition, the IAU collaborates with various scientific organisations globally. Its individual members – structured into divisions, commissions and working groups – are professional astronomers from all over the world, at the PhD level and beyond. They are all active in professional research and education in astronomy.

WHAT IS THE OAD?

The Office of Astronomy for Development (OAD) is a global office that is mandated to use astronomy to drive positive developmental change. This office was established through a joint partnership between the IAU and the South African National Research Foundation (NRF). It was inaugurated on 16 April 2011 at its location in the South African Astronomical Observatory. The purpose of the OAD is to implement the IAU's strategic plan 2010-2020 'Astronomy for Development'. This plan describes the potential of astronomy to contribute to sustainable development. The OAD was established to mobilise the necessary human and financial resources in order to realise the field's scientific, technological and cultural benefits to society.

The OAD is tasked with establishing

and strategically coordinating Regional Offices and Language Expertise Centres across the world, as well as initiating, supporting and funding programmes in three core areas: Astronomy for Universities and Research, Astronomy for Children and Schools, and Astronomy for the Public.

REGIONAL OFFICES

The OAD has led the establishment of nine regional offices around the world. Some focus on a particular geographic region (these are known as Regional Offices of Astronomy for Development or ROADs) while others focus on a specific language or cultural region (these are known as Language Expertise Centres of the OAD or LOADs). These offices were established on the principle that a single office cannot sufficiently cater for all the specific cultural and language needs of all regions of the world. In each of these regional offices there is at least the equivalent of one full-time person to coordinate activities.

Since 2012, nine regional offices have been established (listed below in alphabetical order of host country):

- The South West and Central Asian Regional Office at Byurakan Astrophysical Observatory (BAO) in Armenia
- The East Asian Regional Office and

Chinese Language Expertise Centre is jointly hosted by the Kavli Institute for Astrophysics, Beijing Planetarium and Yunnan Observatory in China

- The Andean Regional Office at three collaborating institutions across two countries (Colombia and Chile): Universidad de Los Andes, Parque Explora-Planetario de Medellín and Sociedad Chilena de Astronomía
- The East African Regional Office is jointly hosted by the Ethiopian Ministries of Science and Technology and Education, the Ethiopian Space Science Society, and Addis Ababa University in Ethiopia
- The Arab Regional Office and Arabic Language Office is hosted by the Arab Union for Astronomy and Space Sciences and located at the United Nations Regional Centre for Space Science and Technology Education in Jordan
- The West African Regional Office at the Centre for Basic Space Science (CBSS), National Space Research and Development Agency (NASRDA) at the University of Nigeria in Nigeria
- The Portuguese Language Office at Núcleo Interativo de Astronomia (NUCLIO), in collaboration with the Institute of Astrophysics and Space Sciences in Portugal
- The South East Asian Regional Office is hosted by the National Astronomy Research Institute of Thailand (NARIT) in Thailand
- The Southern African Regional Office is hosted by Copperbelt University in Zambia.

ELEMENTS OF ASTRONOMY FOR DEVELOPMENT

The OAD uses astronomy to drive sustainable development by fostering education in three focus areas or task forces (universities and research, children and schools, and general public). To date, the OAD has funded 86 projects around the world, as well as ad hoc pilot projects in South Africa.

Task Force 1 focuses on using astronomy to develop any aspect of research, teaching or learning at tertiary level. Universities and research projects include university twinning





programmes, workshops on astronomy, coding or data reduction, as well as developing open-access course materials for tertiary education. Task Force 2 is aimed at pre-primary, primary and secondary education, as well as children and youth outside the formal education systems. The excitement of astronomy can be used to inspire and interest young people in science and technology. Astronomy can also support science, technology, engineering, and mathematics (STEM) education both formally and informally. Task Force 3 focuses on providing astronomy access to everyone, regardless of age, class, gender, educational background, etc. This task force includes public outreach, scientific literacy, and inclusion in science as well as interactions between history, art, culture and astronomy.

CALL TO ACTION

A key part of the implementation of the IAU Strategic Plan is carried out by means of an annual call for proposals. During the call, individuals and organisations that aim to use astronomy for societal benefit can apply for funding for their project ideas. The proposed projects are judged on merit in terms of their potential of using astronomy to address problems or challenges related

to development. The IAU earmarks approximately €110 000 per year for each call, with individual grants generally ranging between €500 and €15 000, depending on the scope of the project.

In addition to the annual call for proposals, the OAD also funds ad hoc projects that use astronomy for sustainable development. Some of the previously funded ad hoc projects or programmes include:

► Astrocomputing

This was a project aimed at exploring ways in which computing skills in astronomy can be applied to other fields.

► AstroEDU

This was a project aimed at allowing educators and astronomers to submit activities in a standard format which allows for efficient distribution and use by teachers around the world.

► AstroSense

This is a project led by Dr Wanda Diaz-Merced, a blind astrophysicist and computer scientist who develops software to analyse astronomical data through sound. Additionally, the OAD supports initiatives in the development of tactile astronomy resources, such as the 3D moon developed by the 'Touch of the Universe' OAD-sponsored project.

► AstroVARSITY

This is a project which intends to

provide course and tutorial resources for mathematics and physics lecturers at undergraduate level in order to use astronomy to enhance science teaching.

Even with the office providing funding to astronomy-for-development projects, the demand still surpasses the supply. The office receives quite a number of applications each year but usually does not have enough funds to propel those projects. Such unfunded projects are placed on a recommended list on the OAD website, with the intention of attracting other sources of funding.

Should you wish to get involved in some of the OAD's work, please do get in touch. Volunteers, interns and visiting fellows are always welcome and have contributed immensely in the past.

'Astronomy is a unique and cost-effective tool for furthering sustainable global development, because of its technological, scientific and cultural dimensions.'

Mangakane Karabo Makola is a communications intern at the IAU-Office of Astronomy for Development. Her interests include marketing communication, public relations, strategic organisational communication and journalism. She graduated from the University of Limpopo with a BA Honours in Media Studies.

Another eye towards the sky – unveiling South Africa's Optical Space Research Laboratory

SANSA's robust endeavours to strengthen the country's role in multinational space science research, this time specifically in upper-atmosphere studies, came to fruition with the unveiling of the Optical Space Research (OSR) Laboratory at the South African Astronomical Observatory (SAAO) in Sutherland on 6 April this year.

This state-of-the-art facility will be used solely for research and to host space monitoring projects with national and international partners.

'Space science research is complex and requires significant multinational collaboration. The unique capabilities of this facility will provide crucial space science data to meet national and international obligations, as well as raise the standard of South African research and supply information about unanswered scientific questions to enhance scientific development,' says SANSA CEO, Dr Val

Munsami. Aligned with SANSA's human capacity development imperative, the OSR Laboratory will also be used by space science students nationally and internationally for research projects.

SANSA's hosting agreement with the SAAO facilitated the construction of the OSR Laboratory in 2016. The unique location of the observatory in Sutherland, which enables optical and radio research of the atmosphere, is

radio quiet and offers the optically dark, clear seeing conditions that make it an ideal location for the laboratory.

SANSA has a partnership agreement with the German Aerospace Centre (DLR), to host a space debris tracking station within the OSR Laboratory. The facility will include a space debris tracking telescope as part of SMARTnet™ (Small Aperture Robotic Telescope Network), a dedicated sensory network based on telescope systems. 'Satellite safety and reliability depend on identifying threats, such as collisions, and using countermeasures to deal with hazardous situations,' says Dr Hauke Fiedler, Team Leader of Space Situational Awareness at DLR.

The space debris tracking telescope will be operated remotely by the DLR German Space Operation Centre together with the Astronomical Institute of the University of Bern, according to a SMARTnet™ observation plan, to identify non-star objects that could pose a collision hazard. 'This will enable the research team to activate collision avoidance measures



DLR, SAAO and SANSA team with the space debris tracking telescope. SANSA

to ensure the safe operation of satellites,' says Dr Fiedler. The collaboration will also provide a knowledge exchange partnership that will initiate space debris tracking know-how in South Africa.

'Research of the Earth's atmosphere and ionosphere is crucial for understanding our near-Earth space and the interconnected processes that govern our natural environment and impact the technology we rely on daily. We will use the OSR initially to study atmospheric gravity waves to gain greater insight into the dynamics of the Earth's middle atmosphere,' says Prof. Kosch, Chief Scientist at SANSA's Hermanus facility in the Western Cape. 'Such knowledge is important because the middle atmosphere couples space weather from above with terrestrial weather below.'

SANSA will also use the laboratory to record a phenomenon called 'sprites', following its recording of the first images of sprites over Africa from Sutherland on 11 January 2016. Triggered by large cloud-to-ground lightning strikes during major thunderstorms, sprites are optical gas discharges from the top of convective thunderstorm clouds that appear as brief flashes of very bright light, lasting between 1 - 10 milliseconds, at an altitude of 50 - 100 km.

Given the millions of lightning strikes that occur annually, the rarity of the reported sightings is surprising. 'Our observations of sprites pave the way for more comprehensive observations at multiple wavelengths to improve our understanding of how sprites are triggered and their effects on the upper atmosphere,' says Kosch. The camera in the OSR Laboratory can detect sprites as far away as Bloemfontein, Lesotho and Port Elizabeth, covering a large section of the summer lightning activity area. It can also detect sprites over the ocean near Port Elizabeth and East London, where South Africa has the relatively rare feature of lightning over the ocean. This will enable the SANSA scientists to determine whether sprites also occur over the ocean.

The laboratory houses specialised research equipment, including an airglow imager to observe atmospheric gravity waves in the mesosphere through a variety of wavelengths; night-vision video cameras to observe sprites in white-light and multiple wavelengths;

an ELF (extremely low frequency) receiver to observe lightning and sprites in the ELF spectrum; a mesospheric temperature mapper to estimate mesospheric temperature and a SBAS (satellite-based augmentation system) receiver for aircraft navigation.

'There is no doubt that this facility will add significantly to our knowledge about the Earth's upper atmosphere and further

enable SANSA to leverage the benefits of space science and technology for socio-economic development, environmental conservation and space asset management in service of humanity,' says SANSA MD, Dr Lee-Anne McKinnell.

Issued by: SANSA, Catherine Webster, Communication Practitioner



Prof. Kosch and students with the OSR Lab. SANSA



SANSA CEO, Dr Munsami and Dr Hauke Fiedler, Head of Space Situational Awareness at DLR. SANSA



SANSA CEO and SANSA MD unveiling the OSR Lab. SANSA

Researchers use 'Fitbits' to track elephant sleep in the wild

Why we sleep is one of the enduring unanswered mysteries of modern science. Along with such activities as eating, protecting yourself and reproducing, sleep is common to all animals.

Some, like whales, dolphins, seals and certain birds, do it in a very unusual manner, sleeping with only half their brain at a time, some sleep a lot and other animals need less sleep.

'While there are many hypotheses regarding the function of sleep, the ultimate purpose of sleep is yet to be discovered,' says Prof. Paul Manger, from the School of Anatomical Sciences at University of the Witwatersrand (Wits).

Lack of sleep (in some animals) can – even over a relatively short term – lead to brain damage, and in the longer term death, which can be seen in the human conditions fatal familial insomnia and sporadic fatal insomnia.

Generally, larger animals tend to sleep less than smaller animals, but do elephants fit this trend?

Behavioural studies of elephant sleep in zoos show that they sleep for around four hours per day and can sleep standing up or lying down – but how much do they sleep and how do they sleep in their natural environment?

Working in the Chobe National Park in Botswana, Manger, Dr Nadine Gravett, and Dr Adhil Bhagwandin from Wits, along with colleagues from the NGO, Elephants Without Borders, Botswana, and the University of California, Los Angeles, used small activity data loggers, scientific versions of the well-known consumer fitness and wellness tracker, Fitbit, to study the sleeping patterns of elephants in the wild.

'We reasoned that measuring the activity of the trunk, the most mobile and active appendage of the elephant, would be crucial, making the reasonable assumption that if the trunk is still for five minutes or more, the elephant is likely to be asleep,' says Manger.

The team outfitted two matriarch elephants with an activity data logger and a GPS collar with gyroscope, noting when they used their trunk, when they moved around and where and when they were lying down to sleep.



Prof. Paul Manger and his team insert an activity data logger into the trunk of an elephant during the study. Wits University

The main finding of the study, recently published in the journal *PlosOne*, was that the two matriarch elephants slept only two hours per day on average, and this sleep occurred mostly in the early hours of the morning, well before dawn.

'The data also indicated that environmental conditions (temperature and humidity, but not sunlight) are related to when the elephants fell asleep and when they woke up (which happens well before dawn),' says Manger. 'This finding is the first that indicates that sleep in wild animals is likely not to be related to sunrise and sunset, but that other environmental factors are more crucial to the timing of sleep.'

The team also found that the wild elephants could sleep while standing up, or while lying down. Lying down to sleep only happened every three or four days and for about an hour, and it is likely that these were the only times the elephants could go into REM, or dreaming sleep, suggesting that elephants may dream only every few days.

'REM sleep (or dreaming) is thought to be important for consolidating memories, but our findings are not consistent with this hypothesis of the function of REM sleep, as the elephant has well-documented long-term memories, but does not need REM sleep every day to form these memories,' says Manger.

Lastly, they found that the two elephants, when disturbed by predators, poachers, or a bull elephant in musth, could go without sleep for up to 48 hours, and would walk up to 30 km to get away from perceived danger. This put a great deal of distance between the elephant herd and any source of danger, but at the expense of a night's sleep.

'Understanding how different animals sleep is important for two reasons. First, it helps us to understand the animals themselves and discover new information that may aid the development of better management and conservation strategies, and, second, knowing how different animals sleep and why they do so in their own particular way, helps us to understand how humans sleep, why we do, and how we might get a better night's sleep.'

*Issued by: Schalk Mouton
Senior Communications Officer, Wits Communications*



An elephant wearing a gyroscope around her neck and a data logger in her trunk. Wits University

A kiss of death – mammals were the first to produce venom

CT scans of fossils of the pre-mammalian reptile, *Euchambersia*, show anatomical features designed for venom production.

Africa is a tough place. It always has been. Especially if you have to fend off gigantic predators like sabre-toothed carnivores in order to survive. And, when you're a small, dog-sized pre-mammalian reptile, sometimes the only way to protect yourself against these monsters is to turn your saliva into a deadly venomous cocktail.

That is exactly what a distant, pre-mammalian reptile, the therapsid *Euchambersia*, did about 260 million years ago, in order to survive the rough conditions offered by the deadly South African environment. Living in the Karoo, near Colesberg in South Africa, the *Euchambersia* developed a deep and circular fossa (a space in the skull), just behind its canine teeth in the upper jaw, in which a deadly venomous cocktail was produced, and delivered directly into the mouth through a fine network of bony grooves and canals.

'This is the first evidence of the oldest venomous vertebrate ever found, and what is even more surprising is that it is not in a species that we expected it to be,' says Dr Julien Benoit, researcher at the Bernard Price Institute for Palaeontological Research at the University of the Witwatersrand in South Africa.

'Today, snakes are notorious for their venomous bite, but their fossil record vanishes in the depth of geological times at about 167 million years ago, so, at 260 million years ago, they evolved venom more than a 100 million years before the



An artist's impression of the *Euchambersia*. Wits University



The skull of the *Euchambersia* fossil shows the large space for the venom glands, in the top jaw, right behind the front teeth (just to the right of Dr Julien Benoit's index finger). - Wits University

very first snake was even born.'

As venom glands don't fossilise, Benoit and his colleagues from Wits University, in association with the Natural History Museum of London, used cutting-edge CT scanning and 3D imagery techniques to analyse the only two available fossilised skulls of the *Euchambersia*, and discovered stunning anatomical adaptations that are compatible with venom production. Their results were published in the open access journal, *PlosOne*, in February.

'First, a wide, deep and circular fossa to accommodate a venom gland was present on the upper jaw and was connected to the canine and the mouth by a fine network of bony grooves and canals,' says Benoit. 'Moreover, we discovered previously undescribed teeth hidden in the vicinity of the bones and rock: two incisors with preserved crowns and a pair of large canines, that all had a sharp ridge. Such a ridged dentition would have helped the injection of venom inside a prey.'

Unlike snakes like vipers or cobras, which actively inject their prey with venom through needle-like grooves in their teeth, the *Euchambersia*'s venom

flowed directly into its mouth, and the venom was passively introduced into its victim through ridges on the outside of its canine teeth.

'*Euchambersia* could have used its venom for protection or hunting. Most venomous species today use their venom for hunting, so I would rather go for this option. In addition, animals at that time were not all insectivorous, particularly among therapsids, which were very diverse.'

Issued by: Schalk Mouton,
Senior Communications Officer
Wits Communications



Dr Julien Benoit with the skull of the *Euchambersia* fossil that was found near Colesberg, in the Eastern Cape Province of South Africa, in 1966. Wits University

MIDLANDS. magic

Megan Jooste describes the excitement of doing research, with Lize Joubert-van der Merwe

**Afromontane
grasslands occur
at relatively high
altitudes in Africa.**

Megan Jooste

My first experience as a research assistant was working in the KwaZulu-Natal (KZN) Midlands with Dr Lize Joubert-van der Merwe, who is a postdoctoral student at Stellenbosch University. We were surveying biodiversity in the Afromontane grassland biome to determine the conservation status of these habitats.

In preparation for spending a month in the Midlands (a place I don't know), I went through several field guides and books to get a better idea of the local flora and fauna. Even so, I was not prepared for the endless luscious greenery covering the rolling hillsides – a spectacular contrast to the drought-stricken Western Cape.

THE AFROMONTANE GRASSLANDS

Lize Joubert-van der Merwe is developing an easy-to-use index to determine the conservation value of the Afromontane grasslands in the Midlands. This requires a thorough understanding of the biodiversity of the area, as well as the primary drivers and threats to this diversity. Lize's project emphasises unique species within her sampling sites, which included rare geophytes, indicator plant species and some large bird species. During the month of fieldwork, my identification skills improved daily and I enjoyed finding new and unfamiliar

species. Three species that left a lasting impression were the Pineapple Lily (Fig. 1), a unique orchid species (Fig. 2) and the Drakensberg Sugarbush (Fig. 10).

FROM FLORA TO FAUNA

The local fauna was not forgotten. Cool and misty days were spent taking close-up photographs of insects, as they move less in this weather. The dragonflies and antlions sitting peacefully in the long, wet grass were relatively easy to admire (Fig. 3), while other insects took shelter from the thick mist and rain. We spent sunny days catching grasshoppers (Fig. 11) and butterflies with nets ... or at least trying to. This is always a tricky task so simply catching one is an achievement. On the last day of our trip I was lucky enough to catch a Green-banded Swallowtail (Fig. 8) and a Mocker Swallowtail. They are lightning fast and nimble and you are lucky to see one, let alone catch one! This was a momentous occasion as we could confirm previous sightings and add them to our collection of species.

I should mention that like most people I was under the impression that the biggest and most glamorous butterflies would be considered a notable find, but this was not the case. It turns out that the smaller and more plainly coloured Lycaenidae butterflies (Fig. 4) were more ecologically important since they are typically classified as indicator species in the

grasslands. These butterflies tell us about habitat quality since they have a smaller home range. This rule also applied to the small, wingless Lentulidae grasshoppers that we collected. A variety of other insects also drew my attention, such as the exquisite Flower mantid (Fig. 5) and Blister beetles that are well known garden pests (Fig. 6).

AND DON'T FORGET THE BIRDS

When we first heard cranes calling we mistakenly assumed that they were the more common Blue Cranes, but much to our surprise, after following their calls and seeing their distinctive large size and white necks, we realised that the calls were coming from a pair of critically endangered Wattled Cranes. Our next encounters were slightly unsettling as they challenged a particular phobia of mine. We came across a Puff Adder and two Rinkhals within a short stretch of road. Needless to say, we called it quits that morning, as that patch of unburned grassland clearly did not want us poking around. Regardless, I made a point of learning more about these particular snakes and realised that we were actually fortunate to have seen them in their natural habitat. Throughout the month I also saw Black-backed jackals, bushpigs, Southern Ground Hornbills, waterbuck and a Crowned Eagle – species that I had

hoped to see during the fieldwork. The variety of animals and plants that we came across were much more abundant than I could ever have imagined.

THREATS TO DIVERSITY

Unfortunately, we also came across various factors that threaten the pristine grasslands habitat. The magnificent Nguni, Bonsmara and Brahman cattle graze on some of the best grass varieties. However, as beautiful as these creatures may be, the reality is that their overgrazing is causing a decline in biodiversity as well as changing the appearance of entire landscapes. The 'dongas' (erosion gulleys where water gathers and cuts away into the poorly vegetated hillsides) that scar some of the slopes are tell-tale signs of the long-term impacts of overgrazing. Apart from these animal-mediated disturbances, certain invasive plants such as the introduced Scottish Thistle (*Cirsium vulgare*) dominate parts of the landscape. Sadly, it's not just the cattle or thistles that are threatening diversity, but as we explored

the landscape, we came across numerous holes where endemic medicinal plants (Fig. 7) had been harvested. Unsustainable harvesting has led to a noticeable decline in natural population sizes.

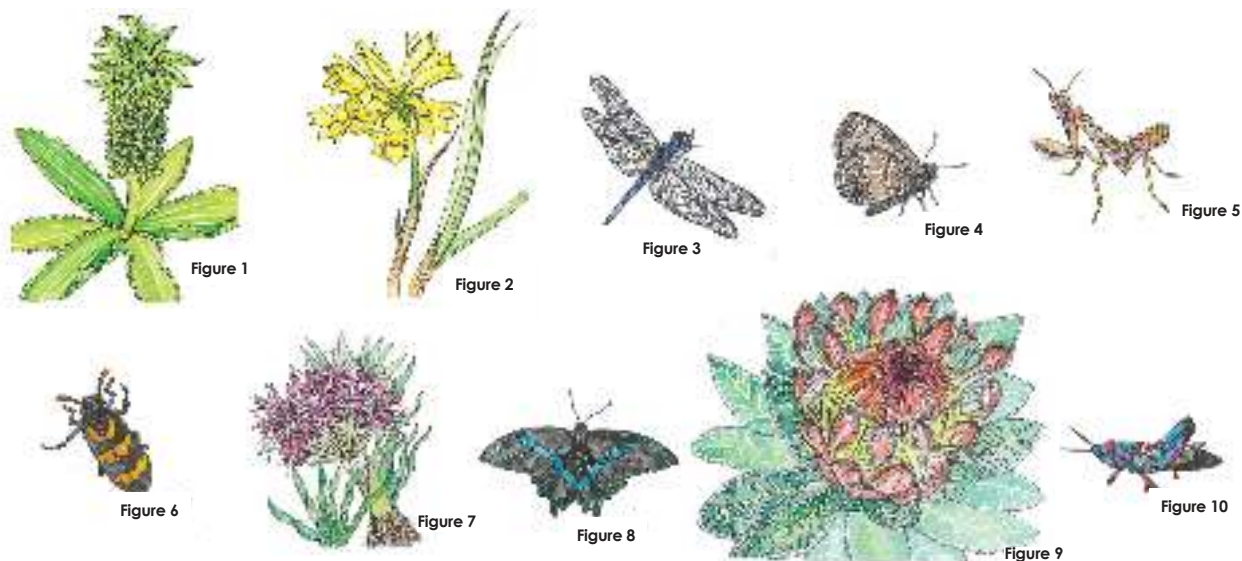
JOURNEY'S END

After surveying 70 study sites over the course of our visit, our mission was complete and it was time to head back to prepare for the start of the 2017 academic year. In the meantime, Lize Joubert-van der Merwe's research continues and is steadily making its way into management guidelines, which will aid in the conservation of grasslands. After this eventful month I have a clear idea of what fieldwork entails and have gained valuable insight into how research is conducted. When it comes to choosing a dissertation topic, I will certainly use this fieldtrip as a point of reference. Lize was an amazing mentor. Her passion for her research is contagious and her work ethic sets a great example. On a slightly different and more colourful note, the month spent in the

magical Midlands inspired me to try and capture the beauty of the diverse plants and insects with a series of scientific illustrations. I hope that my account of assisting with fieldwork will inspire others and assist with preserving this spectacular ecosystem for future generations.

Megan Jooste is a third year Conservation Ecology student at Stellenbosch University. She has a passion for the outdoors and loves a bit of both worlds – terrestrial and aquatic ecology. She is looking forward to pursuing a career in conservation ecology and hopes to aid with the advance of environmental education and scientific communication by uniting her research interests with a passion for illustration.

Lize Joubert-van der Merwe is passionate about research that has practical value for the commercial sectors of agriculture and forestry. She is also a mentor within the Teaching and Development Programme of the Faculty of AgriScience, Stellenbosch University, which places her in the position to help students work on their talents, and develop their skills outside curricular activities.



• Figure 1: The Pineapple lily (*Eucomis autumnalis*) is one of the major species of the Afromontane grasslands. iSpot link: <http://www.ispotnature.org/node/867189>

Figure 2: What a joy it was to find a bright yellow *Eulophia leontoglossa* flower among the tall grass! iSpot link: <http://www.ispotnature.org/node/867619>

• Figure 3: We found many dragonflies along waterways. iSpot link: <http://www.ispotnature.org/node/866959>

• Figure 4: The Marsh Blue is part of a family of butterflies that are sensitive to environmental disturbances due to their relatively small size. iSpot link: <http://www.ispotnature.org/node/881571>

• Figure 5: Flower mantids are expertly camouflaged among the flowers of their host plants while waiting for their prey. iSpot link: <https://www.ispotnature.org/node/781540>

• Figure 6: Blister beetles are a common sight on flowers. iSpot link: <http://www.ispotnature.org/node/866545>

• Figure 7: Gifbol (*Boophone disticha*) is a well-known grassland species that is highly sought-after in the medicinal trade. iSpot link: <http://www.ispotnature.org/node/751162>

• Figure 8: The elusive Green-banded Swallowtail. iSpot link: <http://www.ispotnature.org/node/866875>

• Figure 9: The Drakensberg Sugarbush (*Protea roupelliae* subsp. *roupelliae*). iSpot link: <http://www.ispotnature.org/node/867210>

• Figure 10: A Rooibaadjie (*Dictyophorus spumans*) is usually black and red; however, the varieties in the KZN Midlands are either green and red, or blue and red. iSpot link: <http://www.ispotnature.org/node/867606>

All illustrations by Megan Jooste

Decolonising social sciences

What a new university in Africa is doing to decolonise social sciences. By Jess Auerbach

It's not often that you get to create a new university from scratch: space, staff – and curriculum. But that's exactly what we're doing in Mauritius, at one of Africa's newest higher education institutions. And decoloniality is central to our work.

I am a member of the Social Science Faculty at the African Leadership University (ALU). Part of our task is to build a canon, knowledge, and a way of knowing. This is happening against the backdrop of a movement by South African students to decolonise their universities; Black Lives Matter protests in the United States; and in the context of a much deeper history of national reimagination across Africa and the world.

With this history in mind our faculty is working towards what we consider a decolonial social science curriculum. We've adopted seven commitments to help us meet this goal, and which we hope will shift educational discourse in a more equitable and representative direction.

SEVEN COMMITMENTS

#1 By 2019, everything we assign our students will be open source

Like most institutions of higher education in Africa (and across much of the world) ALU's library is limited. Students often deal with this by flouting copyright and piracy laws and illegally downloading material. We don't want to train our students to become habitual law breakers. Nor do we want them to accept second-tier access to commodified knowledge.

Our aspiration is that by 2019 everything we assign in our programme

will be open source. This will be achieved by building relationships with publishers, writers and industry leaders, and negotiating partnerships for equitable access to knowledge. This will ensure that a new generation of thinkers is equipped with the analytic tools they need.

It will also move towards undoing centuries of knowledge extraction from Africa to the world that has too often taken place with little benefit to the continent itself.

#2 Language beyond English

Students who read, write and think in English often forget that knowledge is produced, consumed, and tested in other tongues.

We commit to assigning students at least one non-English text per week. This will be summarised and discussed in class, even when students are unable to read it themselves. Our current class comprises of students from 16 countries who between them speak 29 languages. English is the only language they all share. Exposing students to scholarly, policy, and real-world work that's not in English means they are constantly

reminded how much they don't know.

As we grow, students will also be expected to learn languages from the continent: both those that originated in colonialism (Arabic, English, French, Portuguese), and those that are indigenous such as isiZulu, Wolof, or Amharic.

#3 1:1 Student exchange ratio

Having cross-cultural experiences, particularly as an undergraduate, has become an important part of demonstrating work readiness and social competency in a 'globalised' world. But scholars have shown that globalisation is often uneven. Strong currencies enable such experiences, so those who benefit usually come from Europe and North America.

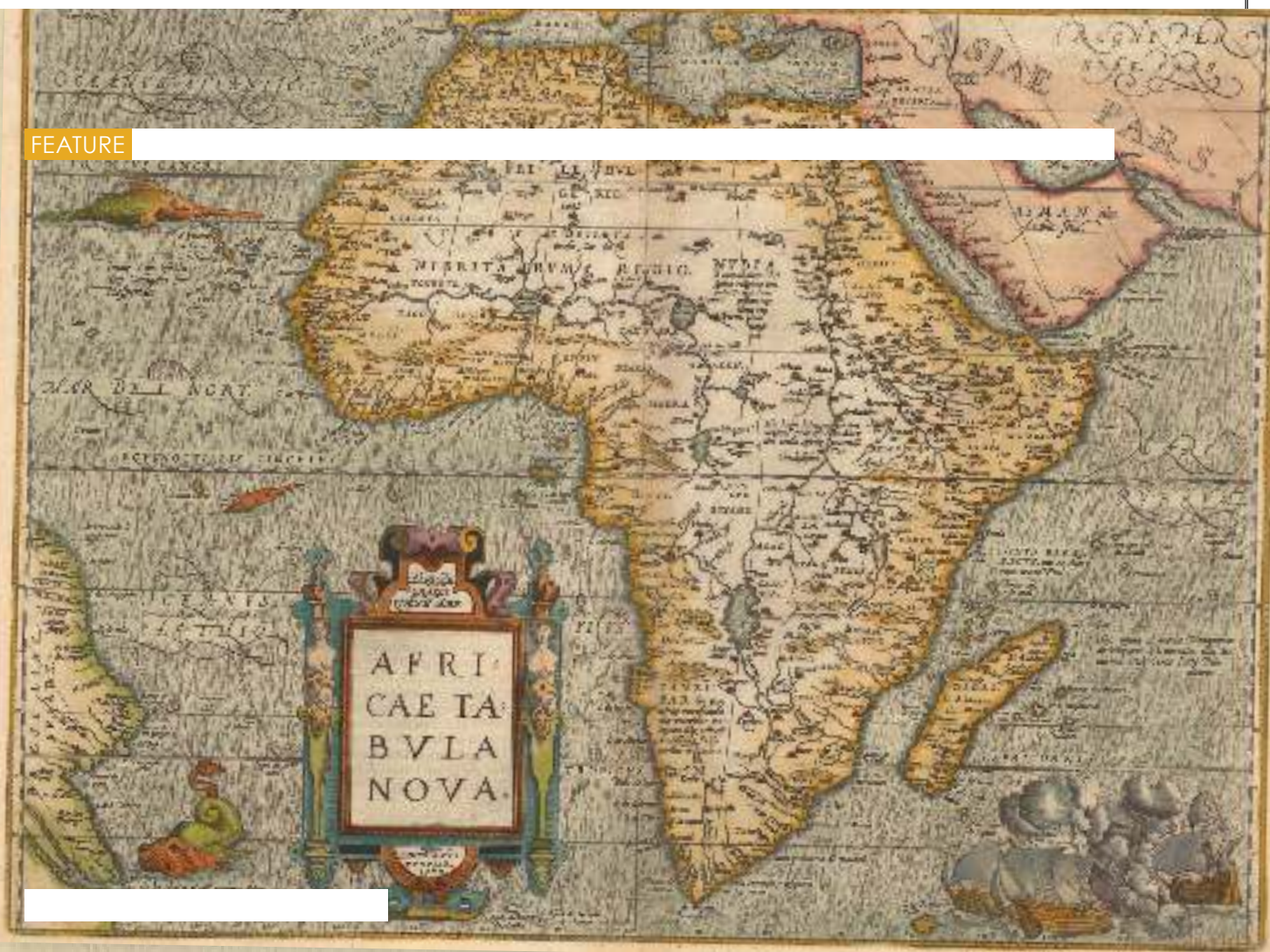
This has had huge implications for higher education, where 'student exchange' usually takes place at a ratio of 10:1 – ten Americans or Norwegians, for instance, exploring South African townships, for one Ghanaian who might make it to the Eiffel Tower.

In Social Sciences the body is the research tool and the mind the laboratory in which experiments are undertaken. We support as much exchange as possible across the broader institution. But our commitment when it comes to student exchange is strictly 1:1 – one ALU student goes abroad for every one exchange student we welcome into our classroom.

#4 Text is not enough

Africa's long intellectual history has only recently begun to be recorded and stored through text. If students are exposed only to written sources, their

We don't want to train our students to become habitual law breakers. Nor do we want them to accept second-tier access to commodified knowledge.



knowledge is largely constrained to the eras of colonisation and post-coloniality.

To instil a much deeper knowledge and more sensitive awareness to context and content, we are committed to assigning non-textual sources of history, culture, and belief: studying artefacts, music, advertising, architecture, food, and more. Each week students engage with at least one such source to attend to the world around them in a more careful way.

#5 We cannot work alone Social scientists often assign themselves the role of deconstructor: unpacking power, race, capitalism and consumption with glorious self-righteous abandon. My colleagues and I recognise that we cannot work alone, and require our students to play a central role in contributing to the university's outputs.

We design our curricula in such a way that students are compelled to create, iterate, work with feedback, apply that feedback, and critically appraise it. We want them to collaborate with as wide a range of other people as possible, stretching them to use language and the tools of analysis that they acquire in their training with real-world implication. For example, students recently worked

with our legal, policy, and learning teams to write the university's statement on diversity.

#6 Producers, not only consumers

The students who choose to come to the university bring with them tremendous insight and experience. These are often developed and augmented by spending time in the quintessential multi-cultural environment of the campus and dormitories. That allows certain fusions, tensions and commonalities to emerge much more clearly than they might in other places.

Working and living within this environment, it's essential that students start contributing to discourses surrounding Africa as early as possible. It might take years to know how to write a publishable scholarly article – but an op-ed, podcast or YouTube video is not quite so demanding. This allows students to get accustomed to their voices contributing to and shaping public dialogue in and about Africa.

#7 Ethics above all Social Sciences both reflect and shape the world. Our programme,

then, is committed to the principle of 'do no harm', and also to be an impetus for good.

Students will learn to think and act to the highest ethical standards, and to feel confident in asking the same of others working with them. This is essential in bringing into being a world in which Africa's place is both central – as it has arguably always been to global capitalism – and also respected.

COLLABORATION

It's early days at ALU. There's a lot we still need to do, and it will take time for us to build the institution into what we collectively envision. These seven commitments are an important foundation for the Social Sciences.

We're inviting responses and collaborations through our blog, through email or through collaborations with our students.

Jess Auerbach teaches Social Sciences at the African Leadership University, Mauritius.

This article was first published in The Conversation.

Hominin neighbours

*Homo naledi: living alongside Homo sapiens.
Breaking news from Wits University*

Scientists recently announced that the Rising Star Cave system has revealed yet more important discoveries, only a year and a half after it was announced that the richest fossil hominin site in Africa had been discovered, and that it contained a new hominin species named *Homo naledi* by the scientists who described it.

The age of the original *H. naledi* remains from the Dinaledi Chamber has been revealed to be startlingly young. *H. naledi*, whose discovery was first announced in September 2015, was alive some time between 335 and 236 thousand years ago. This places this population of primitive small-brained hominins at a time and place that makes it likely that they lived alongside *H. sapiens*. This is the first time that it has been demonstrated that another species of hominin survived alongside the first humans in Africa.

The research, published recently in three papers in the journal *eLife* (elifesciences.org), presents the long-awaited age of the *H. naledi* fossils from the Dinaledi Chamber and announces the new discovery of a second chamber in the Rising Star cave system, containing additional specimens of *H. naledi*. These include a child and a

partial skeleton of an adult male with a remarkably well-preserved skull.

The new discovery and subsequent research was done by a large team of researchers from the University of the Witwatersrand (Wits), James Cook University, Australia, the University of Wisconsin, Madison, United States, and more than 30 additional international institutions.

The team was led by Professor Lee Berger of Wits in Johannesburg, South Africa, and a National Geographic Explorer in Residence. The discovery of the second chamber with abundant *H. naledi* fossils includes one of the most complete skeletons of a hominin ever discovered, as well as the remains of at least one child and another adult. The discovery of a second chamber has led the team to argue that there is more support for the controversial hypothesis that *H. naledi* deliberately disposed of its dead in these remote, hard to reach caverns.

The dating of *H. naledi* is the conclusion of the multi-authored paper: *The age of Homo naledi and associated sediments in the Rising Star Cave, South Africa*, led by Professor Paul Dirks of James Cook University and Wits University.

A RECENT SPECIES

The *H. naledi* date is surprisingly recent. The fossil remains have primitive features that are shared with some of the earliest known fossil members of our genus, such as *H. rudolfensis* and *H. habilis*, species that lived nearly two million years ago. On the other hand, however, it also shares some features with modern humans. After the description of the new species in 2015, experts had predicted that the fossils should be around the age of these other primitive species. Instead, the fossils from the Dinaledi Chamber are barely more than one-tenth that age.

‘The dating of *H. naledi* was extremely challenging,’ noted Dirks, who worked with 19 other scientists from laboratories and institutions around the world, including labs in South Africa and Australia, to establish the age of the fossils. ‘Eventually, six independent dating methods allowed us to constrain the age of this population of *H. naledi* to a period known as the late Middle Pleistocene.’

The age for this population of hominins shows that *H. naledi* may have survived for as long as two million years alongside other species of hominins in Africa. At such a young age, in a period known

Wits University/Marina Elliott

as the late Middle Pleistocene, it was previously thought that only *H. sapiens* (modern humans) existed in Africa. More critically, it is at precisely this time that we see the rise of what has been called 'modern human behaviour' in southern Africa – behaviour attributed, until now, to the rise of modern humans and thought to represent the origins of complex modern human activities such as burial of the dead, self-adornment and complex tools.

THE DATING GAME

The team used a combination of optically stimulated luminescence dating of sediments with uranium-thorium dating and palaeomagnetic analyses of flowstones to establish how the sediments relate to the geological timescale in the Dinaledi Chamber.

Direct dating of the teeth of *H. naledi*, using uranium series dating (U-series) and electron spin resonance dating (ESR), provided the final age range. 'We used double blinds wherever possible,' says Professor Jan Kramers of the University of Johannesburg, a uranium dating specialist. Dr Hannah Hilbert-Wolf, a geologist from James Cook University who also worked on the Dinaledi Chamber, noted that it was crucial to figure out how the sediments within the Dinaledi Chamber are layered, in order to build a framework for understanding all of the dates obtained.

'Of course we were surprised at the young age, but as we realised that all the geological formations in the chamber were young, the U-series and ESR results were perhaps less of a surprise in the end,' added Professor Eric Roberts, from James Cook University and Wits, who is one of the few geologists to have ever entered the Dinaledi Chamber, due to the tight 18 cm-



Left to right: Marina Elliott, Maropeng Ramalepa and Mpume Hlophe.

Wits University/Wayne Crichton

wide constraints of the entrance chute.

Dr Marina Elliott, Exploration Scientist at Wits and one of the original 'underground astronauts' on the 2013 Rising Star Expedition, says she had always felt that the naledi fossils were 'young'. 'I've excavated hundreds of the bones of *H. naledi*, and from the first one I touched, I realised that there was something different about the preservation, that they appeared hardly fossilised.'

HOMO NALEDI'S SIGNIFICANT IMPACT

In an accompanying paper, led by Berger, entitled *Homo naledi and Pleistocene hominin evolution in subequatorial Africa*, the team discuss the importance of finding such a primitive species at such a time and place. They noted that the discovery will have a significant impact on our interpretation of archaeological assemblages and our understanding of which species made them.

'We can no longer assume that we know which species made which tools, or even assume that it was modern humans that were the innovators of some of these critical technological and behavioural breakthroughs in the archaeological record of Africa,' says Berger. 'If there is one other species out there that shared the world with "modern humans" in Africa, it is very likely there are others. We just need to find them.'

John Hawks of the University of Wisconsin-Madison and Wits University, an author on all three papers, says: 'I think some scientists assumed they knew how human evolution happened, but these new fossil discoveries, plus what we know from genetics, tell us that the southern half of Africa was home to a diversity that we've never seen anywhere else.'

'Recently, the fossil hominin record has been full of surprises, and the age of *H. naledi* is not going to be the last surprise that comes out of these caves I suspect,' adds Berger.



Homo naledi may have lived at the same time as the first modern humans. Left: 'Neo' skull of *Homo naledi*. Middle: Kabwe skull from Zambia, an archaic human. Right: Omo 2 skull, one of the earliest modern humans. Wits University/John Hawks

A NEW CHAMBER AND SKELETON

In a third paper published at the same time in *eLife*, entitled *New fossil remains of Homo naledi from the Lesedi Chamber, South Africa*, the team announces the discovery of a second chamber, within the Rising Star cave system, which contains more remains of *H. naledi*.

‘The chamber, which we have named the Lesedi Chamber, is more than a hundred meters from the Dinaledi Chamber. It is almost as difficult to access, and also contains spectacular fossils of *H. naledi*, including a partial skeleton with a wonderfully complete skull,’ says Hawks, lead author on the paper describing the new discovery. Fossil remains were first recognised in the chamber by Rick Hunter and Steven Tucker in 2013, as fieldwork was underway in the Dinaledi Chamber.

The name ‘*Lesedi*’ means ‘light’ in the Setswana language. Excavations in the Lesedi Chamber began later, and would take nearly three years.

NO EASY ACCESS

‘To access the Lesedi Chamber is only slightly easier than the Dinaledi Chamber,’ says Elliott, who was lead excavator of the fossils from the new locality. ‘After passing through a squeeze of about 25 cm, you have to descend along vertical shafts before reaching the chamber. While slightly easier to get to, the Lesedi Chamber is, if anything, more difficult to work in due to the tight spaces involved.’

Hawks points out that while the Lesedi Chamber is ‘easier’ to get into than the



‘Neo’ skull of *Homo naledi* from the Lesedi Chamber. Wits University/John Hawks

Dinaledi Chamber, the term is relative. ‘I have never been inside either of the chambers, and never will be. In fact, I watched Lee Berger being stuck for almost an hour, trying to get out of the narrow underground squeeze of the Lesedi Chamber.’ Berger eventually had to be extracted using ropes tied to his wrists.

The presence of a second chamber, distant from the first, containing multiple individuals of *H. naledi* and almost as difficult to reach as the Dinaledi Chamber, gives an idea of the extraordinary effort it took for *H. naledi* to reach these hard-to-get-to places, says Hilbert-Wolf.

‘This likely adds weight to the hypothesis that *H. naledi* was using dark, remote places to cache its dead,’ says Hawks. ‘What are the odds of a second, almost identical occurrence happening by chance?’

So far, the scientists have uncovered



‘Neo’ skull from Lesedi Chamber (left) with DH1 *Homo naledi* skull from Dinaledi Chamber (right).

Wits University/John Hawks

more than 130 hominin specimens from the Lesedi Chamber. The bones belong to at least three individuals, but Elliott believes that there are more fossils yet to be discovered. Among the individuals are the skeletal remains of two adults and at least one child. The child is represented by bones of the head and body and would likely have been under five years of age. Of the two adults, one is represented by only a jaw and leg elements, but the other is represented by a partial skeleton, including a mostly complete skull.

MEETING HOMO NALEDI

The team describes the skull of the skeleton as ‘spectacularly complete’. ‘We finally get a look at the face of *H. naledi*,’ says Peter Schmid of Wits and the University of Zurich, who spent hundreds of hours painstakingly



Dr Marina Elliott inside the Rising Star cave system. Dirk van Rooyen/ Wits University



Geologist Dr Hannah Hilbert-Wolf studying difficult to reach flowstones in a small side passage in the Dinaledi Chamber. Dirk van Rooyen/ Wits University

reconstructing the fragile bones to complete the reconstruction.

The skeleton was nicknamed 'Neo' by the team, chosen for the Sesotho word meaning 'a gift'. 'The skeleton of Neo is one the most complete ever discovered, and technically even more complete than the famous Lucy fossil, given the preservation of the skull and mandible,' says Berger.

The specimens from the Lesedi Chamber are nearly identical in every way to those from the Dinaledi Chamber, a remarkable finding in itself. 'There is no doubt that they belong to the same species,' says Hawks. The Lesedi Chamber fossils have not been dated yet, as dating would require destruction of some of the hominin material. 'Once described, we will look at the way forward for establishing the age of these particular fossils,' says Dirks. Elliot adds, however, that as the preservation and condition of the finds are practically identical to that of the *H. naledi* specimens from the Dinaledi Chamber the team hypothesises that their age will fall roughly within the same time period.

Berger believes that with thousands of fossils likely remaining in both the

Lesedi and Dinaledi Chambers, there are decades of research potential. 'We are going to treat ongoing extraction of material from both of these chambers with extreme care and thoughtfulness and with the full knowledge that we need to conserve material for future generations of scientists, and future technological innovations,' he says.

Fifty-two scientists from 35 departments and institutions were involved in the research.

Wits Vice-Chancellor and Principal, Professor Adam Habib said: 'The search for human origins on the continent of Africa began at Wits and it is wonderful to see this legacy continue with such important discoveries.'

'The National Geographic Society has a long history of investing in bold people and transformative ideas,' said Gary E. Knell, president and CEO of the National Geographic Society, a funder of the expeditions that recovered the fossils and established their age.

'The continued discoveries from Lee Berger and his colleagues showcase why it is critical to support the study of our human origins and other pressing scientific questions.'

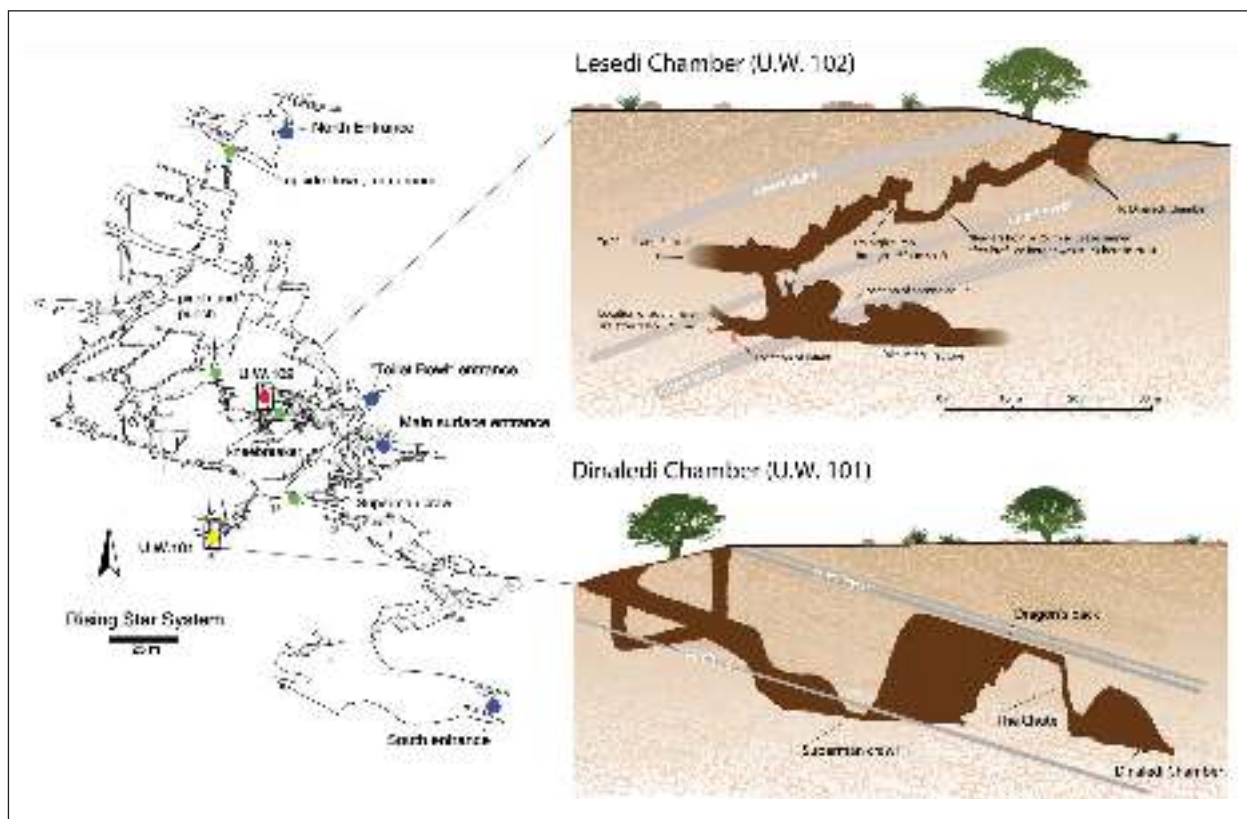
PUBLIC DISPLAY

The original fossils of this exciting new discovery, as well as *H. naledi* fossils from the first Rising Star Expedition will be put on public display at Maropeng, the Official Visitor Centre for the Cradle of Humankind World Heritage Site from 25 May 2017. This exhibit of the largest display of original fossil hominin material in history, form part of an exhibition called 'Almost Human'.

This exhibition will be housed in 'The Gallery'. This state of the art exhibition space was built as part of the Gauteng Government Infrastructure Upgrade Project.

Maropeng is getting ready to receive thousands of visitors wanting to see the exhibition and the new fossils. In 2015, when *H. naledi* was first put on display, some 3 500 visitors per day made their way to Maropeng. 'It was an extraordinary thing to experience,' says Michael Worsnip, Managing Director of Maropeng. 'It was something like a pilgrimage – a wonderful celebration of our heritage as a country, a continent and a planet.'

Issued by Schalk Mouton, Senior Communications Officer, Wits University

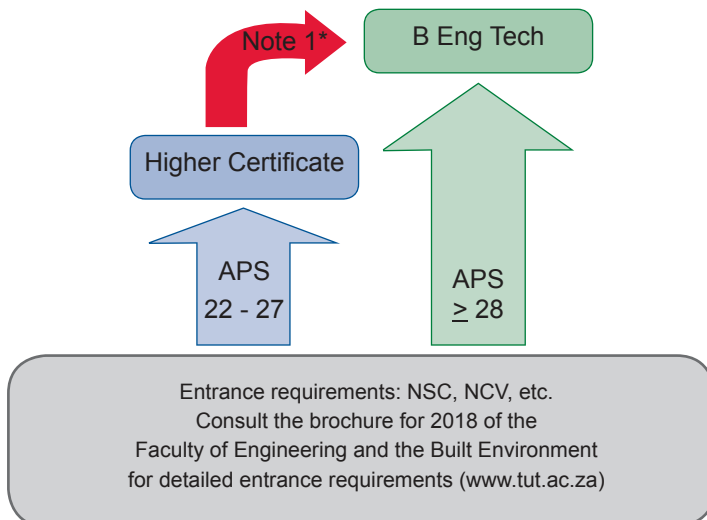


Schematic of the Rising Star cave system. Marina Elliott/Wits University



Faculty of Engineering and the Built Environment

The introduction of the HEQSF in the Higher Education sector required all public and private Higher Education Institutions (HEIs), including Tshwane University of Technology (TUT), to revise all its qualifications to ensure alignment with the HEQSF.



**Note 1: Students who performed well in the Higher Certificate (HC) may be admitted into the B Eng Tech.*

The following new HEQSF aligned qualifications are presented from 2018:

- Higher Certificate in Construction Engineering (Civil)
- Higher Certificate in Electrical Engineering
- Higher Certificate in Industrial Engineering
- Higher Certificate in Mechanical Engineering
- Bachelor of Engineering Technology in Civil Engineering
- Bachelor of Engineering Technology in Electrical Engineering
- Bachelor of Engineering Technology in Industrial Engineering
- Bachelor of Engineering Technology in Mechanical Engineering
- Bachelor of Engineering Technology in Mechatronics
- Bachelor of Engineering Technology in Polymer

Admission requirements for the Higher Certificate in Engineering

A National Senior Certificate or an equivalent qualification, with at least a (4) for English, (4) for Mathematics and (4) for Physical Science. Total APS score: 24. This is the general requirement for the Faculty and it may differ for individual Higher Certificates programmes. This is a one-year qualification.

Admission requirements for the Bachelor of Engineering Technology (B Eng Tech)

A National Senior Certificate (NSC – completed Grade 12 in and after 2008), with an endorsement of a bachelor's degree or an equivalent qualification, with at least a *substantial achievement* of (5) for English, (5) for Mathematics and (5) for Physical Science. Total APS score: 28. This is a three-year qualification (integrated theory and practical).

The B Eng Tech meets the educational requirements for registration as a Professional Engineering Technologist with ECSA.

Departments of Building Sciences, Geomatics, Chemical Engineering, Metallurgical Engineering and Materials Engineering continue to present the current NATED151 qualification during 2018. The new HEQSF aligned qualification will start to phase in during 2019. Please consult the Prospectus of the Faculty of Engineering and the Built Environment (www.tut.ac.za) for more information.

Admission requirements for the Diploma in Building

A minimum score of (4) in English, (3) in Mathematics and (3) in Physical Science. Total APS score: 25. Admission is subject to available space.

Admission requirements for the Diploma in Industrial Design

A National Senior Certificate or an equivalent qualification with at least an adequate achievement of (4) for English. Total APS score: 21. In order to be considered for admission to this qualification, you must first meet the minimum academic requirements. All applications should be supplemented with a portfolio.

Admission requirements for the National Diploma: Surveying

A National Senior Certificate with an endorsement of a bachelor's degree or a diploma, or an equivalent qualification, with an achievement level of at least 4 for English (home language or first additional language), 4 for Mathematics/Technical Mathematics and 3 for Physical Science/Physical Science. A total APS of 23 may be considered

Admission requirements for the Bachelors of Architecture

A minimum score of (4) in English is required with a minimum APS score of 25. Admission is subject to the completion of a Potential Assessment Test (a 6 hour written test) and availability of space. The purpose and intention of the assessment is to select only students who are likely to be successful in their studies in Architecture. The University reserves the right to select the best candidates for this programme.

B Arch meets the educational requirements for registration as a Professional Architectural Technologist with SACAP.

Admission requirements for Postgraduate Qualifications

A Baccalaureus Technologiae in Engineering, Bachelor of Engineering Technology Honours, Bachelor of Engineering or a Bachelor of Science in Engineering (in any related field), or an NQF level 8 qualification in Engineering (or any related field), with an aggregate of 60 % for the final year of study obtained from an accredited South African university. The postgraduate programmes involve a research project with a dissertation and specified subjects. The candidates should prove that they understand a particular problem in industry to which their research applies and are able to analyse it, arrive at logical conclusions or a diagnosis and make proposals for improvement or elimination of the problems. Please consult the Prospectus available on the web site (www.tut.ac.za) for more information.

The Faculty phased in the Master of Engineering (M Eng) and Doctor of Engineering (D Eng) qualifications in 2017. The B Eng Tech (Hons) leads to a Masters of Engineering in Chemical, Civil, Electrical, Mechanical, Metallurgical and Polymer Technology. M Arch meets the educational requirements for registration as a Professional Architect with SACAP.

For more information:

Faculty Marketer: Ms Zelda Janse van Rensburg
Email: JanseVanRensburgZ@tut.ac.za
Facebook: http://www.facebook.com/TUTengineeringfaculty
Twitter: http://twitter.com/TUTEngineering



BOOK REVIEWS



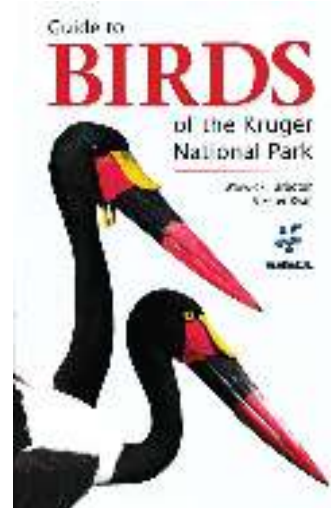
OUR OCEANS EXPLORED

Two Oceans: A guide to the marine life of southern Africa 4ed. By George Branch, Charles Griffiths, Margo Branch and Lynnath Beckley. (Cape Town. Struik Nature. 2016)

Earlier editions of this book have been the major reference that scientists, students, divers and beachcombers have used to identify and learn about marine life in all its forms for many decades. Our local shores and seas contain abundant life – from sponges to whales and seaweeds, to dune forests and beach habitats.

This fully revised and expanded fourth edition contains accounts for over 2 000 species, with many updates and new photographs. The introduction to the book covers the coasts of southern Africa, showing the two main currents that meet to provide the rich environment that gives life to the abundance of species off our shores. Currents and tides are explained, as is the exploitation and conservation of species. An understanding of classification is vital to any identification guide and there is a concise and useful introduction to this, with a detailed description of classification of marine groups.

The different generic grouping are in separate sections and each species is illustrated with a colour photograph, a short species account and a distribution map.



THE KRUGER'S BIRDS

Guide to the Birds of the Kruger National Park. By Warwick Tarboton and Peter Ryan. (Cape Town. Struik Nature. 2016)

The Kruger National Park is probably better known for the 'big five' – and these mammal species will undoubtedly be the main reason that many visitors go to the park. However, the bird life in the Kruger is outstanding and abundant in a relatively unchanged high-veld environment.

The Kruger is known as one of the best 'birding' experiences in the world, with something like 500 species recorded in its range, representing more than half the number of species found across southern Africa. The sheer size of the park and its accessibility and infrastructure make it a premier destination for the dedicated group of birdwatchers who travel the globe to expand their 'life list'.

This book is authored by two of South Africa's best-known experts in ornithology and starts with an excellent introduction to the park, its ecology and its avifauna in general. The relationship between geology, climate and birdlife makes this a useful addition to any ecology library.

There are informative species accounts, full-colour photographs and distribution maps that show actual sightings, making this book an invaluable guide for easy identification.

This illustration shows the possible surface of TRAPPIST-1f. NASA/JPL-Caltech

NASA TELESCOPE REVEALS LARGEST BATCH OF EARTH-SIZE, HABITABLE-ZONE PLANETS AROUND SINGLE STAR

NASA's Spitzer Space Telescope has revealed the first known system of seven Earth-size planets around a single star. Three of these planets are firmly located

in the habitable zone, the area around the parent star where a rocky planet is most likely to have liquid water.

The discovery sets a new record for greatest number of habitable-zone planets found around a single star outside our solar system. All of these seven planets could have liquid water – key to life as we know it – under the right atmospheric conditions, but the chances are highest

with the three in the habitable zone.

However, we will not be visiting the planets any time soon ... they are about 40 light-years (376 trillion kilometres) from Earth (about nine billion four hundred million times around the Earth).

This exoplanet system is called TRAPPIST-1, named for The Transiting Planets and Planetesimals Small Telescope (TRAPPIST) in Chile. NASA

HYENAS SAID TO JOIN WOLF PACKS IN UNUSUAL ALLIANCE

Courtesy of University of Tennessee at Knoxville and World Science staff.

Animals of different species sometimes lean on each other in times of adversity – just as humans do, according to a new study.

Vladimir Dinets of the University of Tennessee, Knoxville, working with Israel-based zoologist Beniamin Eligulashvili, examined an unlikely friendship between striped hyenas and grey wolves in the southern Negev Desert, Israel.

Dinets suspects the extreme desert's particularly inhospitable conditions – and a need for food – might have pushed the two enemies into an unusual alliance.

'When necessary, animals can abandon their usual strategies and learn something completely new and unexpected. It's a very useful skill for

people, too,' says Dinets.

Hyenas and wolves are generally not friendly toward other carnivores so Dinets and Eligulashvili were surprised when they saw striped hyenas – little known, mostly solitary relatives of the better-known spotted hyenas of Africa – in the middle of grey wolf packs, moving together through a maze



A striped hyena at the Gir Forest National Park in India. Dr Shamshad Alam – Department of Wildlife Sciences, Aligarh Muslim University, India. CC BY-SA 3.0

of canyons in the southern part of the Negev Desert.

Dinets theorises that both predators tolerated each other because they benefit from being together. Wolves are more agile and can chase and take down all large animals of the region, while hyenas have an acute sense of smell and can locate carrion from many kilometres away. Hyenas also are better at digging out buried garbage and cracking open large bones and tin cans.

Both the grey wolf (*Canis lupus*) and the striped hyena (*Hyaena hyaena*) are found in many geographic areas and overlap in many parts of Asia. However, the southern Negev is the most arid place where both species are known to occur.

The study appears in the journal *Zoology in the Middle East*.

World Science, <http://www.world-science.net>

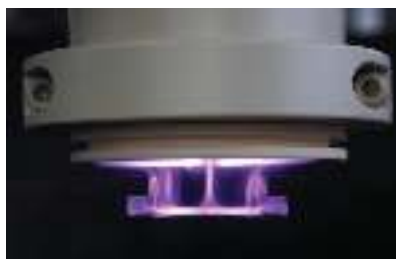
COLD PLASMA: GET STARTED WITH THE DISC JET

Plasmas have long been used in industry to clean surfaces or to process them so that materials like paints or glues stick to them more effectively. The problem was that only flat surfaces could be treated; the plasma simply slid over recesses, cavities or undercuts. Now researchers at the Fraunhofer Institute for Surface Engineering and Thin Films (IST) have combined two plasma processes – the plasma jet and the glide discharge – in order to be able to process three-dimensional components effectively.

Inside the plasma jet, which essentially consists of an electrode and a nozzle, a cold plasma is generated with the help of alternating voltage but because the plus and minus poles of the electrode change constantly, the ions hardly move and release little energy in the form of heat, while only shaking back and forth a little. In this way, the temperature can be kept

low at 30 to 60°C – which is ideal for the treatment of heat-sensitive materials, such as plastics or wood.

The plasma jet, which also detects cavities, recesses and undercuts, works not only physically by roughening the surface slightly (which makes it easier for applied substances to adhere) but also chemically. This occurs because the unstable atoms and molecules of the plasma are highly reactive. *Fraunhofer-Gesellschaft*



The Disc Jet can also be used to process cavities. *HAWK*



STUDENT ENTREPRENEUR BRINGS LIGHT TO SOUTH AFRICAN SCHOOLCHILDREN

UCLA sophomore Luke Mostert would like to own his own business someday, like many enterprising 20-year-olds. What sets him apart from other motivated students is that he already owns 20% of the company he helped launch, SOSA Investments.

For the South African native and his partners business is not just about money. It is also about doing good. That is why SOSA's first initiative is donating solar-powered lights to impoverished South African

schoolchildren to prevent the deadly paraffin-lantern fires that can destroy the informal shack-settlements where they live.

Together, the five friends built a company and attracted funding to help them both donate the solar lanterns, and to sell them to others as a way to raise money for more donations. They launched their awareness campaign in November last year, and made their first donation of 47 lights to a children's home in December. *UCLA*

QUEST MATHS PUZZLE NO. 41



There are 10 people in a house. Everyone wants to shake hands only with people who are shorter than they are. Assuming everyone is a different height, how many handshakes are made?

Answer to Maths Puzzle no. 40:
It's shadow!

Winner: Nia Viljoen

WIN A PRIZE!

Send us your answer (fax, e-mail or snail-mail) together with your name and contact details by 15:00 on Friday 7 July 2017.

THE FIRST CORRECT ENTRY THAT WE OPEN WILL BE THE LUCKY WINNER. WE'LL SEND YOU A COOL TRULY SCIENTIFIC CALCULATOR!

- ▶ Mark your answer 'Quest Maths Puzzle no. 41' and send it to: Quest Maths Puzzle, Living Maths, P.O. Box 195, Bergvliet, 7864, Cape Town, South Africa .
Fax: 0866 710 953.



Email: livmath@iafrica.com. For more on Living Maths phone (083) 308 3883 and visit www.livingmaths.com.

SUBSCRIBE!

Subscribe now to have four quest issues mailed to you and place your order for back issues (subject to availability).

Subscription does not carry over to the next calendar year, provide postal address only.



SUBSCRIPTION FORM 2017

Please fill in and return this form with proof of payment.

I would like to subscribe to 4 issues of Quest: Science for South Africa. My details are (please print):

Title: _____ Name/Initials: _____ Surname: _____

Company/university/institution/school: _____ Student number (to qualify for student rates): _____

Postal address: _____

Code: _____

Work tel.: (____) _____ Fax: (____) _____ Home tel.: (____) _____

Cell: _____ e-mail: _____

How did you hear about QUEST? _____

If you are already a subscriber, are you satisfied with the subscription service? ☐ Yes ☐ No

When would you like your subscription to begin? ☐ Tick here if this is an institutional subscription

(Please fill in below.) ☐ Tick here if this is an individual/personal subscription

Volume Number: _____ Issue Number: _____ ☐ Tick here if this is a gift subscription

Date: _____ Signature: _____

Subscription rates* (4 issues incl. postage) Please tick appropriate rate.

No VAT is charged, as the publisher is not registered for VAT.

South Africa	<input type="checkbox"/> Individuals/Institutions – R130.00	<input type="checkbox"/> Students/Schoolgoers – R 65.00
Neighbouring countries (Southern Africa)	<input type="checkbox"/> Individuals/Institutions – R280.00	<input type="checkbox"/> Students/Schoolgoers – R169.00
Foreign	<input type="checkbox"/> Individuals/Institutions – R234.00	<input type="checkbox"/> Students/Schoolgoers – R182.00

Payment options and contact details.

Payment options

Please make payment by electronic transfer or cash deposit into the following bank account:

Bank: Standard Bank **Account Name:** Academy of Science of South Africa

Account number: 07 149 422 7 **Branch name (code):** Hatfield (011-545)

Reference: QUEST SUB + your name (or institution's name)

Send the completed Subscription Form together with the proof of payment to:

POST: Quest Magazine, PO Box 72135, Lynnwood Ridge, 0040, South Africa

E-mail: tsepo@assaf.org.za **Fax:** 086 576 9519 **Subscription enquiries:** tel. 012 349 6645 OR e-mail: tsepo@assaf.org.za



BSc in Actuarial Science now offered at UJ!

Are you a maths top achiever with impressive grade 12 results? The University of Johannesburg (UJ) is offering the 3-year BSc degree in Actuarial Science from January 2018 and we are looking for you!

The BSc (Actuarial Science) follows the syllabus of most core technical subjects of the Institute and Faculty of Actuaries in the UK, and the Actuarial Society of South Africa. The programme offers an excellent opportunity for you to study toward becoming a qualified Actuary.

Entrance requirements: **Minimum APS score of 33**
Mathematics APS 7 (80%) / English APS 5 (60%)

Applications open on 1 April 2017

For more information contact 011 559 2374/3826
or email web-science@uj.ac.za

<https://www.uj.ac.za/faculties/science>

The Future
Reimagined

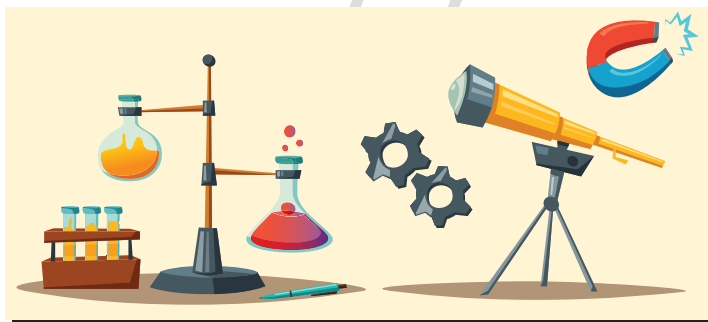
Why Study Physics?

A degree in physics provides a deep understanding of the most fundamental phenomena in the universe while developing modes of thought and approaches to problem-solving that are valued in academia, industry, and beyond. These skills empower physics graduates to succeed in a wide range of careers, such as medicine, law, public policy, financial services, education, engineering and sciences such as physics, astronomy, chemistry, and mathematics.

Our program boasts excellent student to teacher ratios, with a median class size of 20 in upper level courses. Introductory courses have 40-250 students in lectures, but break into groups of less than 50 for tutorials and labs. All of our courses are taught by experienced physicists.



It is like trying to infer something about a musical instrument from the sounds it makes. Some of our group members use telescopes like the Southern African Large Telescope (SALT) to study these pulsating stars, others use computers to model the waves inside stars. Furthermore, our group has purchased a 40 cm - diameter telescope at the Mafikeng campus. Once operational it will be used for research and for educational purposes. Another area of research in the Astrophysics group is cosmology, in which the large-scale structure of the Universe and relativistic laws of gravitation are studied.



Material Science group focuses on heritage artifacts analysis. It boasts of a state-of-the-art Raman spectrometer, PLM and a stereomicroscope. It has part of the Material Science Innovation and Modeling (MaSIM) focus area. The group therefore has access to a lot of analytical instruments that are housed in the Chemistry department.

Electronic Instrument Design group focuses on the design and development of new sensors and microprocessor based instruments.

Opportunities abound for being involved in our community. Our students give to the broader community through outreach activities, and have the opportunity to develop their teaching skills through our Undergraduate Teaching Assistant program. We host colloquia, technical seminars, and public lectures, bringing several world experts to campus frequently.

Research

Research is an important component of our program, and most of Mafikeng Campus physics postgraduate students collaborate with other graduate students on world-class research. Research in the Physics department is in Solar Thermal, Astrophysics, Material Science and Electronics Instrument Design.

Solar Thermal The future and current research of the solar thermal energy research group falls into three main categories:

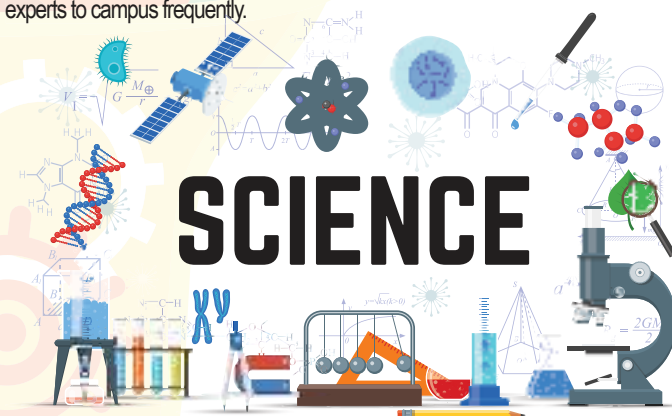
A. Small thermal energy storage systems for domestic applications. The group researches on small scale solar thermal energy storage systems for domestic applications like solar cooking and solar water heating

B. Solar domestic receivers and discharging heat exchangers. Investigations on the optimal design of suitable receivers for domestic parabolic dish concentrators in terms of the energy and the exergy are being carried out.

C. Solar resource measurement

The group in the near future will measure the weekly, monthly and yearly global and direct solar energy irradiation in Mafikeng to provide a database of the solar resource which may be used to develop models for solar resource forecasting.

Astrophysics. The main thrust of our research is in using seismic waves found in A and B stars to infer conditions within stars. This field of study is called Astero-seismology. Much of a star is opaque to light, hence, by normal interpretation of stellar spectra and photometry one can mostly learn about the shallow outer layers of a star where starlight comes from. However, stars with seismic waves, also called pulsating stars, allow astronomers to use the waves to perform seismology on them. These waves travel to most parts of a star, hence, the more we can detect these waves, the more we can infer properties of the whole star.



SCIENCE

Physics at Mafikeng Campus

The **Physics Major** at Mafikeng Campus is flexible, with the option to take courses of varying areas of specialisation. Students choose to concentrate in an area of interest: either **Physics**, or **Electronics**. The program of is customized for each student.



Contact

Private Bag X2046
Mmabatho
2735
Tel: 018 389 2127
Web nwu.ac.za

