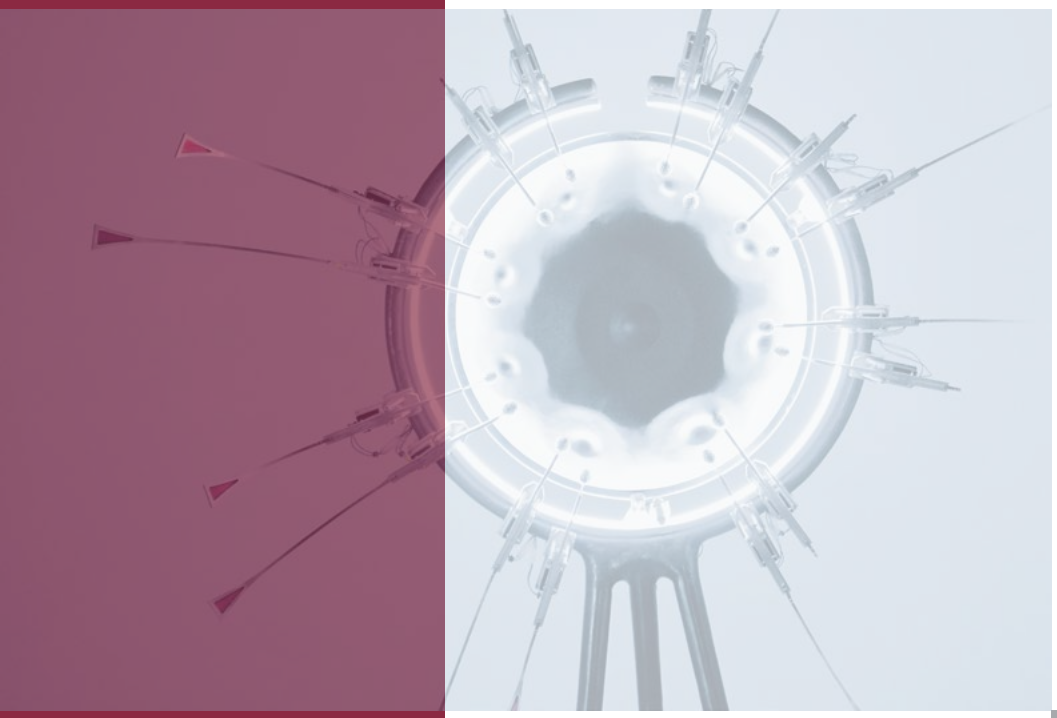
FACULTY OF SCIENCE

Stellenbosch University

2019



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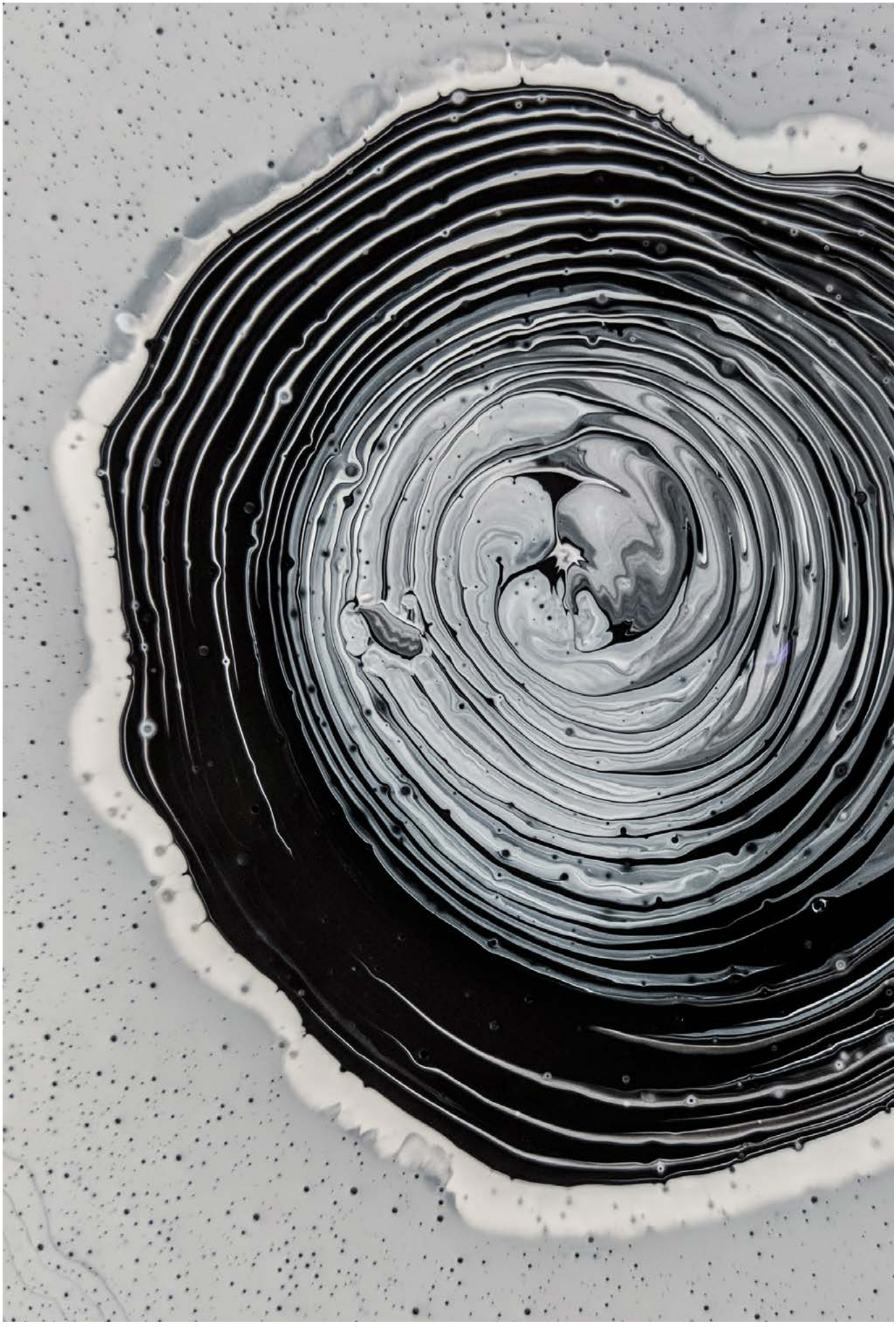


CONTENTS

FROM THE DEAN'S OFFICE

The Faculty of Science plays a significant role in positioning Stellenbosch University (SU) as a leading, research-intensive university. We provide a general formative education in the natural sciences and for professional degrees such as engineering, medicine and actuarial science.

THRIVING UNIVERSITY

The Faculty of Science maintains a strong ethos of excellence in research: 71% of our academic staff has NRF ratings and eight SARChI research chairs and three NRF-DSI Centres of Excellence are associated with the Faculty. Due to the importance of the natural sciences in interdisciplinary research, the Faculty plays an important role in the SU Water Institute, the Centre for Bioinformatics and Computational Biology, the Institute for Biomedical Engineering, the African Microbiome Institute, and the new School for Data Science and Computational Thinking.

Approximately 23% of our students are postgraduates. During 2019 more than 500 BSc-degrees were conferred, including 156 BScHons- and 81 MSc-degrees, as well as a record number of 50 PhD-degrees. However, recent changes in policies and availability of postgraduate bursaries and postdoctoral fellowships pose a challenge to our ability to produce research outputs. In 2019 the Faculty's postgraduate bursary fund offered bursaries to 12 MSc and nine PhD students, but the income generated is not sufficient to sustain the current number of postgraduate students. It is evident that alternative income sources are urgently required to maintain our contribution to SU as a leading research-intensive institution.

The Faculty has reached its 2019 diversity targets for students (36% undergraduate and 39% postgraduate students are BCIA), but the recruitment and intake of new BCIA first year students require special recruitment efforts. Gender imbalance remains a problem in programmes such as Mathematics, where only 28% of postgraduate students are female. In 2019 the Department of Mathematical Sciences hosted the first African Women in Mathematics conference to address this challenge.

The second annual postgraduate symposium, organised by the Science Student Committees from SU and the University of Cape Town, was also hosted on our campus.

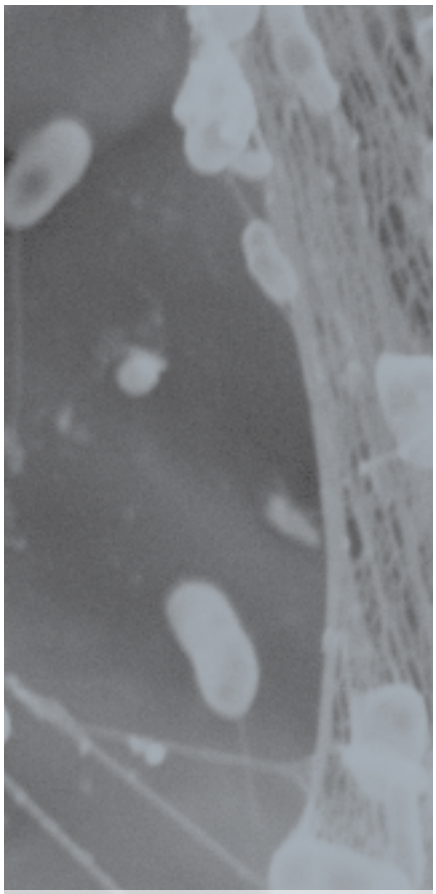
TRANSFORMATIVE STUDENT EXPERIENCE

The scholarship of teaching and learning is encouraged through our Teaching and Learning Hub, addressing issues such as the decolonisation of the sciences, the enhancement of students' critical and analytical thinking skills and the process of scientific reflection.

On an international level, Dr Steve Kroon from the Computer Science Division was selected to participate in the inaugural 2019 Depth First Learning Fellowship. This is an initiative to develop lesson plans to master significant research papers in machine learning and tackles fundamental concepts in mathematics, statistics and information theory.

Dr Marnel Mouton and Dr Ilse Rootman-le Grange won the Best Research-based Paper Award at the annual Scholarship for Teaching and Learning Conference. At the First Year Prestige Dinner, seven lecturers were recognised by top performing first-year students as important role-players in their achievements. Dr Mouton and Prof Gareth Arnott both received Teaching Excellence Awards for 2019.

As part of ongoing efforts to address the success rate of students, Chemistry 164 was the first official hybrid module to be offered as part of SU's hybrid learning project. If a student fails a bottle-neck module such as Chemistry 124 in the first semester, adding another year to their studies, Chemistry 164 (which is equal to Chemistry 124) offers them another opportunity to successfully complete their first year.



In an effort to address the mental health crisis at higher education institutions in South Africa, lecturers participated in a lunch-hour seminar on how to deal with mental health in the postgraduate context.

EMPLOYER OF CHOICE

Faculty management continuously strives to establish a work culture that fosters an enabling working and learning environment. This includes embracing diversity and equity, leveraging unique talents and strengths, promoting life-long learning and celebrating achievements. However, it remains difficult to manage all the expectations with regard to teaching and research, whilst maintaining quality and a positive work culture. During 2019 the Transformation Advisory Group organised workshops on institutional culture, changing behavior through innovation, and employment equity.

Four academics delivered their inaugural lectures: Prof Zurab Janelidze (Mathematical Sciences), Prof Alex Valentine (Botany), and Proff André de Villiers and Catharine Esterhuizen (Chemistry and Polymer Science). Prof Esterhuizen is also the first female full professor in the history of that department.

RESEARCH FOR IMPACT THROUGH NETWORKS AND COLLABORATIONS

Through our research and graduates we have an impact on South Africa's global competitiveness in the sphere of science, technology and innovation. In this regard Prof Guy Midgley, a leading expert in the field of biodiversity and global change science, was awarded the prestigious Humboldt Research Award from the Alexander von Humboldt Foundation in Germany. He was also a lead author on the report "Biodiversity and Ecosystem Services for Africa", one of four regional assessments that formed part of a global biodiversity report, as well as South Africa's National Biodiversity Assessment Report released in October 2019.

The Faculty has established important partners, comprising research councils, governmental organisations, and other higher education institutions, as well as important stakeholders in national and international industries, as illustrated by industry representation on our advisory board. In 2019, the third Research Showcase for industry was hosted in Gauteng. By means of workshops and financial support, staff and students are made aware of entrepreneurial opportunities associated with their work. One of our innovation success stories that started in 2012 is the SharkSafe Barrier™ – a shark-deterrent technology that is currently being tested at La Réunion Island for potential full-scale implementation.

SOCIAL IMPACT

One of the year's highlights was the public lecture "From the Earth to the Moon", organised by Dr Bruce Bartlett to commemorate the 50th anniversary of the Apollo moon landing, involving speakers from mathematics, applied mathematics, history and engineering.

Dr Leanne Seeliger from the SU Water Institute started working with Stellenbosch Municipality to find long-term sustainable solutions to water and sanitation challenges in the informal township Enkanini. A three year partnership between SUWI and the Maastricht School of Management aims to strengthen skills development and job creation in important fields such as agriculture and water governance in South Africa.

Ongoing social impact initiatives include the laboratory-based practicals for high school learners and teachers, mathematics training camps for the SA Mathematics Olympiad, Science Café Stellenbosch talks on current issues, and a series of lectures on the science behind the Nobel Prizes.

AWARDS

Noteworthy awards made during 2019 include the African Union's Kwame Nkrumah Award for Scientific Excellence to Prof Dave Richardson, the SCM Lifetime Achievement Award to Prof Harold Pasch, the South African Mathematical Society's Award for Research Distinction to Prof Stephan Wagner, the South African Chemistry Institute's Gold Medal to Prof Klaus Koch, and the Royal Society of South Africa's Marloth medal to Prof Piet Steyn. Prof Emile van Zyl and Prof Peter Mallon were appointed members of the International Union of Pure and Applied Chemistry (IUPAC) subcommittees on Biotechnology and Polymer Terminology respectively; Prof Faadiel Essop was elevated to a Fellow of the American Physiological Society; Prof Mallon and Prof Willem van Otterlo were elected as president and vice-president respectively of the SACI council, whilst Prof Carol Simon was elected President of the International Polychaete Association.

Ms Sarah Selkirk, an MSc student in Mathematics, received the Faculty of Science's medal for the best MSc student in 2019. She was also awarded a TATA Masters Scholarship at the SA Women in Science Awards, as well as the S_2A_3 award for the best MSc student at SU. The Dean's medal for 2019 was awarded to Freddie de Villiers, a BScHons student in Applied Mathematics, and Emma King, a BScHons student in Physics.

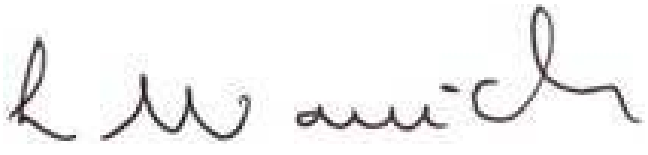
Dr Taboka Chalebgwa won the AIMS-Fields-Perimeter Africa postdoctoral fellowship at the prestigious Fields Institute for Research in Mathematical Sciences in Canada. Other students who fared well include Dr Upenyu Muza (SACI postgraduate award), Ms Lindo Makhathini (SA Council for Natural Scientific Professions' award for an exceptional fourth-year Earth Science graduate), and Mr Jonathan Gloyn-Jones (Geological Society of South Africa's Corstophine medal for an MSc thesis in Earth Sciences with exceptional merit).

Prof Leon Dicks won the 2018 Cipla India world-wide competition for most innovative idea in medical research. Dr Sara Andreotti received the Chairman's award at the Nedbank Business Excellence Awards for her work on the SharkSafe Barrier. An expert in 3D technologies, Prof Anton du Plessis, was recognised by the Department of Trade and Industry for his contributions towards leading SA into the Fourth Industrial Revolution.

LOOKING FORWARD

We strive to recruit the best staff and students, deliver sought after graduates and perform research with impact. Excellence in outputs will enhance our national and international profile, which is critical for long-term financial sustainability. Our teaching and research activities require expensive facilities and equipment, and the maintenance and replacement of these aging assets, spread over 13 of some of the oldest buildings on campus, remains a challenge.

Reduced dependency on statutory funding and unlocking alternative income streams will be key to the future sustainability of the Faculty of Science as a research-led environment of excellence.



PROF LOUISE WARNICH, DEAN: FACULTY OF SCIENCE

DEPARTMENT OF BIOCHEMISTRY

RESEARCH INTERESTS

Steroid hormone biosynthesis and function
Evolution and detection of viruses and bacterial pathogens of potatoes and fruit trees
Molecular systematic and evolutionary studies of plant groups in southern Africa
Antimicrobial peptides – isolation, characterisation and field application
Steroid receptor signal transduction and steroid-binding globulins
Selective Steroid Receptor Modulators (SESRMs) from indigenous South African plants
Enzyme kinetics for systems biology
Mechanistic modelling of pathophysiology of important South African diseases
Mass spectrometry as a tool in metabolomics studies
Steroid hormone biosynthesis by cytochrome P450 enzymes, their metabolism and function, with a focus on the role of 11-oxygenated androgens
Chemical biology and mechanistic enzymology of the metabolic cofactor coenzyme A (CoA)
Mathematical and computational systems biology

RESEARCH HIGHLIGHTS

Prof Dirk Bellstedt, who retired at the end of 2019, consolidated many of his research projects during 2019 and published eight papers in diverse journals. Four of these publications were in the field of plant molecular systematics and plant biology, one reported on vaccine development against mycoplasmas in ostriches and in one, five new species of African fishes, identified by means of DNA sequencing and phylogenetic analysis, were described. Two key publications were published elucidating the control of gene expression of the anthocyanin biosynthetic pathway in the plant group, *Erica*.

Erica regia produces anthocyanins for coloration of the flowers.
Photo: *Dirk Bellstedt*

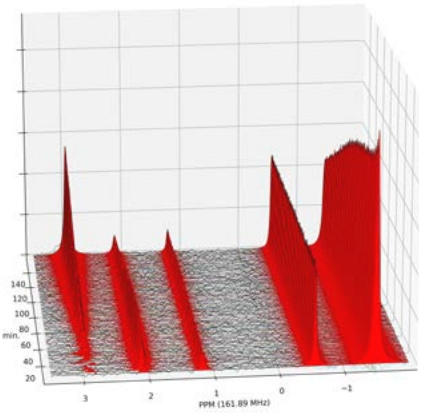
Dr Marianne de Villiers was invited to speak at a symposium on Malaria Research: Crossing Boundaries, organised between the Australian National University and the Humboldt University in Germany as part of the joint Australian-German initiative in the fight against malaria in October 2019. In addition, she also presented her research at the "NRF Community of Practice: Discovering Drugs to Eliminate Malaria" annual symposium and stakeholders meeting held at University of Pretoria Future Africa Institute in November 2019.

Prof Ann Louw was invited to co-author a review on honeybush in the *South African Journal of Botany* to herald the 20 year anniversary of the formal honeybush industry. She was also invited to give a lecture on the work of her group on *Cyclopia* at the 19th International Congress of the International Society for Ethnopharmacology (ISE) in Dresden, Germany, entitled "Combinatorial treatments of Tamoxifen with SM6Met, a selective estrogen receptor subtype modulator (SERSM), from *Cyclopia subternata*". Furthermore, her collaborators at TU-Dresden invited her to give a talk entitled "Targeting ER subtypes in breast cancer: lessons from *Cyclopia*" at the International Alumni Week 2019 of the Technische Universität Dresden in Germany. Furthermore, Prof Louw was invited to contribute a review on the recent work emanating from her laboratory on the implications of glucocorticoid receptor (GR) dimerization to the Research Topic: Glucocorticoids in Immunity and Inflammation in the journal *Frontiers in Immunology* entitled "GR Dimerization and the Impact of GR Dimerization on GR Protein Stablity and Half-Life".

Prof Johann Rohwer gave an oral presentation at the Metabolic Pathways Analysis 2019 conference held in Riga, Latvia, during August 2019, presenting his work on developing novel software tools for computational systems biology. He also spoke at the Beilstein Enzymology Symposium 2019 held in Rüdesheim, Germany, during September 2019, presenting STRENDA DB, the enzyme function database developed by the international STRENDA Commission, which develops Standards for Reporting Enzymology Data and of which he is a member.

For the malaria project in his SARChI group on Mechanistic Modelling of Health and Epidemiology, **Prof Jacky Snoep** co-hosted an international malaria meeting at STIAS in collaboration with the Humboldt University in Berlin and the Australian National University in Canberra. Furthermore, he joined the Community of Practice: Discovering drugs to eliminate malaria, formed by Prof Birkholtz at UP (director), and Proff Chibale (UCT), Koekemoer (WITS), Klumperman (SU), and Banasiak (UP). The detailed mathematical modelling approach advocated in the SARChI project paid off for a long running project together with Prof Siebers of the University of Duisburg/Essen on modelling the Weimberg pathway, with the acceptance of a paper in *Nature Communications*.

Prof Karl Storbeck was invited to present a keynote lecture entitled: "Rethinking sex steroids: Understanding the clinical relevance of 11-oxygenated androgens" at the European Mass Spectrometry: Applications for the Clinical Laboratory conference held in Salzburg, Austria from 22-26 September 2019. He also chaired a session at the same meeting and served as a judge for the poster sessions. Prof Storbeck spent a six-month sabbatical at the Institute of Metabolism and Systems Research (IMSR), University of Birmingham, UK, hosted by Prof Wiebke Arlt. During this time, he focussed on his research into the role of 11-oxygenated androgens in health and disease as well as the use of mass spectrometry for steroid



analysis. As part of this collaboration Prof Storbeck led the effort to review our current understanding of steroid hormone metabolism, published in the *Journal of Steroid Biochemistry and Molecular Biology* and how steroid metabolome analysis can be used to diagnose disorders of adrenal steroid biosynthesis and metabolism, published in the journal *Endocrine Review*. During his time in the UK he also presented seminars on 11-oxygenated androgens at the University of Birmingham and the University of Edinburgh. In collaboration with Prof Elahe Mostaghel from the Fred Hutchinson Cancer Research Centre in Seattle, USA, Prof Storbeck was invited to co-write a book chapter entitled "Canonical and Noncanonical Androgen Metabolism and Activity" for the second edition of the book *Prostate Cancer – Cellular and Genetic Mechanisms of Disease Development and Progression*, published by Springer.

Prof Erick Strauss gave invited seminars at the Department of Biochemistry and Molecular Biology at the Universitat Autònoma Barcelona and at the Department of Chemistry at the University of Mauritius. The latter was presented while he acted as external examiner of the BScHons-degree programme in Chemistry. Prof Strauss was also invited to represent the South African Life Science consortium members participating in the START (Synchrotron Techniques for African Research and Technology) grant programme, which is supported by the GCRF (Grand Challenges Research Fund) of United Kingdom Research and Innovation at the end of (UKRI0, and to report on the status of the programme to the funders. He and his PhD student Konrad Mostert participated in the Gordon Research Conference on Tuberculosis Drug Discovery and Development held at the Rey Don Jaime Grand Hotel in Barcelona, Spain from 7-12 July 2019, where Konrad presented a poster.

Prof Amanda Swart published two articles reporting on the novel enzyme reactions catalysed by the 11β-hydroxysteroid dehydrogenase isoforms in the *Journal of Steroid Biochemistry and Molecular Biology*. She also published an article with her collaborator, Prof Stephen Atkin, at the Royal College of Surgeons in Ireland – Bahrain (RCSI Bahrain), reporting their investigations into isoflavonoid compounds in the journal *Frontiers in Endocrinology*. Her investigations into prostate cancer and benign prostatic hyperplasia were considered of such importance to the field that an article, entitled "The 11β-hydroxyandrostenedione pathway and C11- oxy C21 backdoor pathway are active in benign prostatic hyperplasia yielding 11keto-testosterone and 11keto-progesterone" was published as an open access paper by the editor-in-chief in the *Journal of Steroid Biochemistry and Molecular Biology*.

RESEARCH ACTIVITIES

Prof Donita Africander served on the editorial board of the *Journal for Ethnopharmacology*. She has active collaborations with Profs Jacky Snoep and Karl Storbeck from this department, Dr Carmen Pheiffer from the Medical Research Council, Prof Janet Hapgood from UCT, and Dr Narender Kumar from Rockefeller University, New York City, USA.

Prof Dirk Bellstedt served on the South African Plant Checklist Committee of the South African National Biodiversity Institute, and served as a sub-editor of the journal *Phytotaxa* in 2019. He collaborated with Dr Ulrich Schliewen, Curator of Fishes from the Molecular Lab, SNSB-ZSM Bavarian State Collection of Zoology, Munich, Dr Mike Pirie, Dr Gudrun Kadereit, Prof Regine Claßen-Bockhoff and Dr Somayeh Naghiloo from the Institut für Spezielle Botanik und Botanischer Garten, Johannes Gutenberg Universität, Mainz, and Dr Michael Moeller from the Royal Botanic Gardens Edinburgh in Scotland.

The following conferences were attended by either **Dr Marianne de Villiers** or postgraduate students in her group in order to present research from her laboratory.

- EMBL Conference: BioMalPar XV: Biology and Pathology of the Malaria Parasite. EMBL Advanced Training Centre (28-30 May 2019), Heidelberg, Germany;
- Gordon Research Conference Malaria (30 June - 5 July 2019), Les Diablerets, Switzerland;
- Malaria Research: Crossing Boundaries Symposium (30 September - 2 October 2019), Stellenbosch, South Africa; and
- NRF Community of Practice symposium and stakeholders meeting on Discovering Drugs to Eliminate Malaria (18 November 2019), Pretoria, South Africa.

Prof Ann Louw hosted a delegation, consisting of Profs Oliver Zierau (Molecular Cell Physiology and Endocrinology), Stefan Wanke (Botany), Jan J. Weigand (Chemistry) and Kai Zuber (Physics), from the Technische Universität Dresden, Germany, who visited Stellenbosch University as part of the ERASMUS+ International Staff Mobility for Teaching and/or Training programme. Prof Zierau gave a lecture in the Department entitled "Treatment of menopause related complaints and the role of natural compounds". Prof Louw collaborates within her own department (Prof Johann Rohwer and Dr Nicky Verhoog, on *Cyclopia* and GR dimerization), with the Agricultural Research Centre (ARC) Infruitec-Nietvoorbij (Dr E Joubert and Prof D de Beer, Post-Harvest and Wine Technology Division, *Cyclopia*), with the Vlaams Institute voor Biotechnologie (VIB) and University Ghent in Belgium (Prof Claude Libert, on GR dimerization), with the Technische Universität Dresden, Germany (Prof

Gunter Volmer and Oliver Zierau, on *Cyclopia* and breast cancer), and with the University of Göttingen, Germany (Prof Holger Reichardt, on GR dimerization).

Prof Johann Rohwer was a guest lecturer at the 30th Chris Engelbrecht Summer School, organised by the National Institute for Theoretical Physics (NITheP) on "Foundations of Theoretical and Computational Science", held in February 2019 in the Drakensberg. He is a Member of the international STRENDA (Standards for Reporting Enzymology Data) Commission and is currently the chair of AHASA, the Alexander von Humboldt Association of Southern Africa (South-Western chapter). Prof Rohwer currently serves as Associate Editor for *BMC Bioinformatics,* as Review Editor for *Frontiers in Plant Science* (section Plant Systems Biology), and serves on the Editorial Advisory Board of *In silico Plants,* a new online journal specialising in plant systems biology.

Prof Rohwer has active collaborations with a number of groups, both nationally and internationally: with Dr Rencia van der Sluys, North-West University (on studying the kinetics of glycine N-acyltransferases), with Dr Che Pillay, University of KwaZulu-Natal (on the modelling of cellular redoxin networks), with Dr Egils Stalidzans, University of Latvia, Riga (on bioengineering of the MEP pathway in plants), and with Prof Jonathan Gershenzon, Max Planck Institute for Chemical Ecology, Jena, Germay (on flux and control analysis of isoprene synthesis in plants). He visited the lab of Prof Gershenzon during August 2019.

Prof Jacky Snoep and **Dr Dawie van Niekerk** attended the research symposium Malaria Research Crossing Boundaries during September 2019 at STIAS, Stellenbosch, where their students Ms Kathleen Green and Ms Shade Horn presented posters and Prof Snoep presented a keynote lecture "Modelling glucose metabolism in *Plasmodium falciparum*: from isolated parasite to malaria patients". At the meeting of the NRF Community of Practice in Malaria Elimination held at the Future Africa campus of the University of Pretoria on 18 November 2019, both Dr van Niekerk and Prof Snoep presented research lectures.

Prof Snoep gave oral presentations at the COMBINE (Computational Modelling in Biology) meeting in Heidelberg, Germany, and at the INCOME (Integrative Collaborative Modelling in Systems Medicine) conference in Frankfurt, Germany.

Prof Snoep and Dr van Niekerk are involved in the following collaborations: Prof MF Essop, SU, SA; Prof L-M Birkholtz, UP, SA; Prof V Mizrahi, UCT, SA; Prof B Bakker, University of Groningen, the Netherlands; Prof C Goble, University of Manchester, UK; Prof HV Westerhoff, Vrije Universiteit Amsterdam, the Netherlands; Prof Mattias Goksör, University of Gothenburg, Sweden; Dr Matthias König, Humboldt-University Berlin, Germany; Prof Dr Bettina Siebers, University of Duisburg-Essen, Germany. Prof Snoep serves on the editorial boards of *Molecular Systems Biology, IET Systems Biology, Frontiers in Systems Biology*, and *Metabolomics*.

The group of **Dr Marietjie Stander** published six papers in international journals.

Prof Karl Storbeck presented a keynote lecture entitled "Rethinking sex steroids: Understanding the clinical relevance of 11-oxygenated androgens" at the conference on Mass Spectrometry: Applications for the Clinical Laboratory (MSACL 2019 EU), Salzburg, Austria (September 2019). He also presented guest seminars on the same topic at the Department of Molecular and Cell Biology, University of Cape Town, the Centre for Reproductive Health, University of Edinburgh, Edinburgh, UK, and the Institute of Metabolism and Systems Research, University of Birmingham, UK. He serves as the treasurer for the South African Society for Biochemistry and Molecular Biology (SASBMB) and serves on editorial boards of *Steroids* and *Molecular and Cellular Endocrinology*.

Prof Storbeck has active collaborations within the department and with the University of Cape Town (Prof Janet Hapgood, Molecular and Cell Biology, on the metabolism of progestins), the University of the Western Cape (Prof Tertius Kohn, Sports Science Institute, on the role of 11-oxygenated androgens in skeletal muscle), as well as internationally with the University of Birmingham, Institute of Metabolism and Systems Research, UK (Prof Wiebke Arlt, on the role of 11-oxygenated androgens in health and disease as well as the use of ultra-performance convergence chromatography tandem mass spectrometry for steroid analysis), the University of Oxford, Department of Oxford Centre for Diabetes, Endocrinology and Metabolism, UK (Prof Jeremy Tomlinson on the AKR1D1 mediated metabolism of 11-ketotestosterone), the University of Sheffield, Department of Oncology and Metabolism, UK (Prof Nils Krone on development of zebrafish models for steroidogenic disorders), and the Fred Hutchinson Cancer Research Center, Seattle, USA (Prof Elahe Mostaghel on the role of 11-oxygenated androgens in castration resistant prostate cancer).

Prof Erick Strauss served on the editorial advisory board of the journal *ACS Infectious Diseases* since 2017. He has active collaborations with Prof V. Mizrahi at UCT's Molecular Mycobacteriology Research Unit, Prof Kevin Saliba and Dr Christina Spry at the Australian National University's Research School of Biology, Prof Ody Sibon from the University Medical Centre Groningen, Department of Cell

Biology in the Netherlands, and Prof Cindy Dowd from George Washington University (USA).

Prof Amanda Swart was invited to present a lecture entitled "Novel intermediates are catalysed by 11ß-HDS and CYP17A1 in the C11-oxy backdoor pathway leading to the production of 11-ketodihydrotestosterone" at the annual Endocrine Society meeting (ENDO-2019) in New Orleans, Louisiana held from 23-26 March. She was also an invited speaker at the Cytochrome P450 meeting (ICCP450) held at the University of Queensland in Brisbane, Australia, from 23-27 June 2019 where she presented a talk entitled "The promiscuous role of CYP17A1 in the metabolism of C11-oxy C21 steroids". She was invited to present her research on C11-oxy steroids to clinicians and researchers in the field of steroidogenesis at the Swiss Steroid Symposium 2019 held at the Universitätsklinik für Nephrologie und Hypertonie, on 21 November, in Berne, Switzerland. Her talk was entitled "C11-oxy steroid pathways impacting the endocrine system." Prof Swart visited her collaborator, Prof Christa Flück, for two weeks in November 2019 at the University of Berne, Switzerland, where Prof Swart holds a guest professorship

Prof Amanda Swart has served on the editorial board of *Scientific Reports* since 2014 and continues in this role. She was invited by the Endocrine Society to serve as a member on the Global Engagement Advisory Group which provides guidance and input on matters such as key opportunities and areas of emerging need, facilitating communication in priority countries and organisations, identifying key global leaders and influencers to feed the leadership pipeline.

AWARDS TO STAFF AND STUDENTS

Dr Mervyn Beukes received the Department of Science and Innovation (DSI) and the National Intellectual Property Management Office's (NIPMO) certificate of recognition for development of TB diagnostic technology. Prof Karl Storbeck was the recipient of the HB and MJ Thom bursary to spend a six-month sabbatical in the UK.

ACADEMIC AFFAIRS

In 2019 the Department again had a large cohort of 91 full-time postgraduate students and eight postdoctoral fellows. At the 2019 graduation ceremonies 22 Honours, eight MSc and three PhD students graduated successfully.

NRF-RATED RESEARCHERS		
Internationally acclaimed researchers	Prof Jacky Snoep	Computational Systems Biology
	Prof Johann Rohwer	Computational Systems Biology
	Prof Amanda Swart	Cytochrome P450 and Steroidogenesis
	Prof Erick Strauss	Mechanistic Enzymology and Inhibitor Development
Established researchers	Prof Dirk Bellstedt	Plant Molecular Systematics and Molecular Plant Virology
	Prof Ann Louw	Steroid Receptor Signal Transduction
	Prof Marina Rautenbach	Antimicrobial Peptides
	Dr Marietjie Stander	Mass Spectrometry and Analytical Chemistry
Promising young researchers	Prof Karl Storbeck	Steroid Biosynthesis and Metabolism
	Dr Marianne de Villiers	Chemical Biology, Antimalarial drug design and discovery, infectious diseases, mechanistic enzymology

FUNDING

South Africa

Cancer Association of South Africa (CANSA)
National Research Foundation (NRF) CSR grant
NRF Competitive Support for Unrated Researchers (CSUR)
NRF incentive funding
SA Rooibos council
SACEMA/SARCHI research chair in mechanistic modelling of health and epidemiology

Germany

German Volkswagen Foundation

United Kingdom

Academy of Medical Sciences' Newton Advanced Fellowship
Biotechnology and Biological Sciences Research Council (BBSRC), FAIRDOM grant
British Society for Endocrinology

United States of America

National Institutes of Health (NIH)
National Institutes of Health GCRF
START grant from the STFC/UKRI (UK)

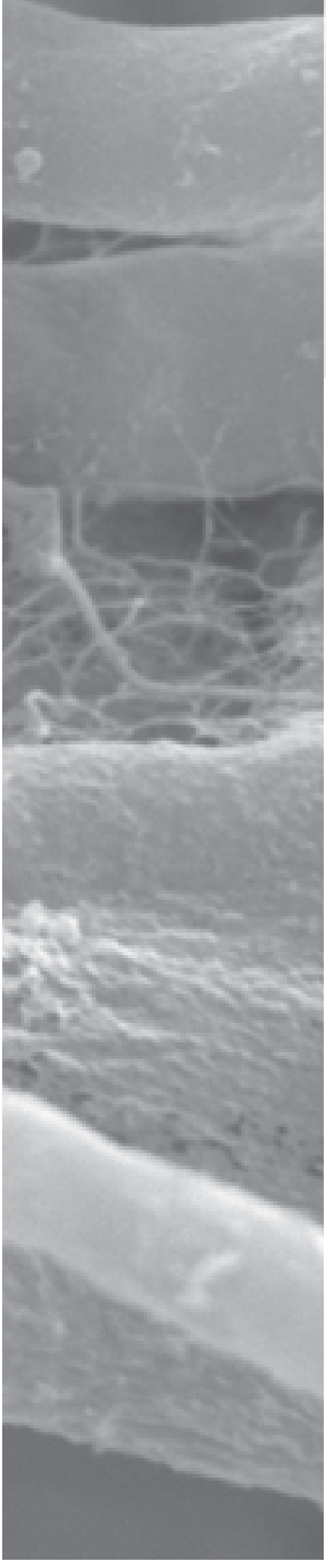
STAFF MATTERS

Dr Mervyn Beukes, previously from the University of Pretoria, joined us as a Senior Lecturer from January 2019. Prof Dirk Bellstedt retired at the end of 2019. Dr Karl Storbeck was promoted to Associate Professor from January 2019.

STAFF LIST

Academic

Prof DJ Africander
Prof DU Bellstedt
Dr M Beukes
Dr A Botes
Dr M de Villiers
Prof A Louw
Prof H Patterton
Prof M Rautenbach
Prof JM Rohwer (Head of department)
Prof JL Snoep
Prof K Storbeck
Prof E Strauss
Dr MA Stander
Dr DD van Niekerk
Dr NJD Verhoog



Extraordinary professors

Prof WCA Gelderblom

Emeritus professors

Prof J-HS Hofmeyr
Prof AC Swart
Prof P Swart

Support staff

Ms W Maart (Secretary)
Mr AP Arends
Mr KD Botha
Mr R Brandt
Dr H Bredell
Mrs L du Toit
Dr Y Engelbrecht
Mrs AP Februarie
Mrs GD Gerstner
Mr CR Jansen
Dr R Louw-Du Toit
Ms RP Louw
Mrs L Prinsloo

Postdoctoral fellows

Dr B Balcomb
Dr T du Toit
Dr A Hamann
Dr T Kouril
Dr V Kumar
Dr D Neveling
Dr W Roos
Dr JA Vosloo

SOCIAL IMPACT

Prof Erick Strauss was interviewed on Monitor, an actuality news programme on the radio station RSG, on the topic of using honey-based treatments for antibiotic infections.

CONTACT DETAILS

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Web: www.sun.ac.za/biochem

DEPARTMENT OF BOTANY AND ZOOLOGY

RESEARCH INTERESTS

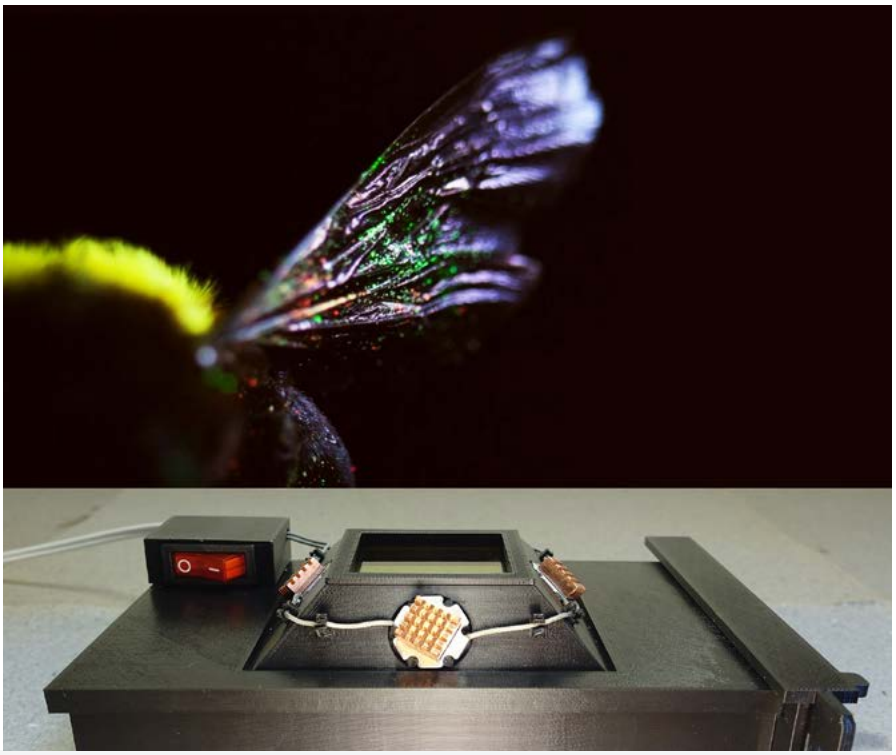
Biotic diversity and ecology of the Cape Region and its coastline
Systematics and molecular ecology
Evolutionary ecology
Nutritional plant physiology and medicinal plant biology
Global change biology
Invasion biology

RESEARCH HIGHLIGHTS

Quantum physics meets ecology – a new method to track pollen grains

Given its important role in natural systems, pollination has historically been a popular focus of study for scientists. However, one frustrating aspect of studying pollination is that, for centuries, we have mostly been limited to studying pollination without accounting directly for its most crucial component – the actual movement of pollen. Tracking the movement of microscopic grains as they get transferred between flowers by flying animals has proven very difficult. To understand pollination, and the role of different flower visitors as pollinators, we need to be able to track pollen grains directly.

PhD student Corneile Minnaar, under the guidance of Prof Bruce Anderson, set out to develop an inexpensive and easily applied technique to track pollen grains. He came across a paper that used quantum dots to track cancer cells in rats and thought that similar methods could be used to track pollen grains. Quantum dots are semiconductor metal crystals that are so small, they behave like artificial atoms. Instead of moving about freely, the minute size of the crystals only allow electrons to occupy two states (quantum confinement). When exposed to UV light, the electrons become excited, jumping from one state to the other and release bright light energy as they jump. Figuring out how to attach quantum dots to pollen grains without damaging the flowers, took more than a year. The next hurdle was detecting the quantum dot labelled pollen grains without a fluorescence stereo microscope. The solution: building a 3D-printable fluorescence box (costing less than R2 000 to make) which can be placed under any standard stereo microscope. After three years of work, they finally had a working pollen tracking technique that allowed them to track pollen grain movement between flowers as well as on the bodies of insects. A description of the quantum-dot pollen tracking technique, along with a validation experiment, has been published in *Methods in Ecology and Evolution*. – *Dr Corneile Minnaar*



Pictured above, a Carpenter bee with quantum-dot labelled pollen visible on the wing. The bee was placed inside a 3D-printable fluorescence box (bottom image) to reveal quantum-dot labelled pollen grains. *Photos: Corneile Minnaar*

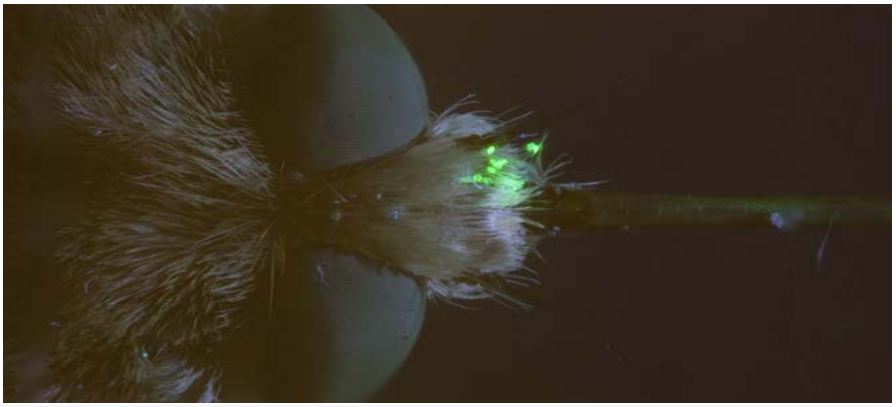
Speciation: how plant populations keep their pants on

Speciation is the primary process behind the astonishing biodiversity of multicellular life on earth. Because the process of speciation can take millions of years, it is often hard to see and study (imagine trying to spot change in the hand of a clock that takes a million years to make a circuit). But the properties that make many species different give us clues about how the process of speciation occurs. We know that many species look different because they are adapted to different ecological conditions. For example, polar bears have evolved white coats to match the permanently frozen landscapes which they roam, whereas the coats of brown bears are adapted to the landscapes of greens and browns which they mostly roam. But when brown bears and polar bears (or most other closely related species) meet one another, they seldom mate or produce viable offspring. If they did produce plenty of viable offspring, the differences that they display would soon be lost in those inter-mixed offspring, and the offspring would not be recognisable as distinct species. Thus, the study of the speciation process consists of two important components: What are the ecological differences that cause adaptive divergence between populations (e.g. how do snow-covered vs forested landscapes cause bear appearance to change), and how do barriers to geneflow evolve, (e.g. what stops the brown and white bears from mating or producing viable offspring), to stop divergent populations from interbreeding and thus losing their differences when they make contact?
To answer these questions, my colleagues and I often turn to studying very recently diverged populations that have just come in contact. It's a little like catching the populations in the very act of speciating (with their pants up, if they are not able to mate with one another). By catching them in these early stages of the speciation process, we are able to study the ecological factors that drive their divergence and allow them to maintain their differences.

A long tongued fly *(Moegistorhynchus longirostris)* visits a long tubed iris, *Lapierousia anceps*. *Photo: Bruce Anderson*

We studied a population of long tubed iris plants *(Lapeirousia anceps)* which had evolved long tubes to match the tongue lengths of their fly pollinators. My colleague, Prof Anton Pauw, found that flies from different places have different tongue lengths and the iris plants had adapted to the flies in each population by evolving different tube lengths. But one population intrigued us because it consisted of flowers with both short and long tubes. There were very few individuals with intermediate tube length; this suggested that we had caught two recently diverged populations.

To figure out what was stopping them from mating, we needed to know more about how pollen moves from one plant to another, and whether pollen from short tubed plants is more likely to travel to other short tubed plants than to long tubed plants and vice versa. Tracking pollen has seldom been done because pollen grains are difficult to mark. But Corneile Minnaar, my PhD student, found that we could use quantum dots to label pollen grains. By marking the pollen of short and long tubed flowers with different colours, we were able to track the movements and ultimate fates of those pollen grains. Using this technique, we determined that pollen movement accounted for at least one of the buttons that kept those proverbial pants up. Indeed, pollen seldom moved between individuals with different tube lengths, and for the most part, pollen movement and mating occurred between plants with similar tube lengths. Because we could follow pollen grains tagged with quantum dots, we could also finally explain why pollen wasn't moving between short and long tubed plants: short and long tubed plants placed and received their pollen on different parts of the pollinator — in other words, one of the 'buttons' discouraging mating between long and short tubed individuals.



Pollen grains coated with fluorescent green quantum dots help us to differentiate the grains of one specific flower from the other grains carried by a long proboscid fly pollinator. *Photo: Corneile Minnaar*

These results suggest that when plants from different populations diverge in response to their pollinators' morphology, the adaptive differences in tube length automatically help to facilitate what we call reproductive isolation. In reality, complete reproductive isolation is usually achieved by using multiple buttons. For the long tubed iris, further reproductive barriers include slight genetic incompatibilities between plants with different tube length, and pollinators that choose to forage preferentially on one floral form over the other. With all the buttons securely in place, they function like a chastity belt, keeping divergent populations faithful to one another. – *Prof Bruce Anderson*

What's in a name? Towards clarifying the identities of bait polychaetes

Polychaetes are widely collected as bait in South Africa, but only three species are reported consistently in the literature. Recent research conducted by my research group found that fishermen in the Western Cape Province collect more than eleven species known by ten common names, and that common names are not applied consistently. For example, the names blood-, mussel-, coral-, moonshine-, wonder- and pudding worms each apply to more than one species which may also belong to more than one genus or even family. Similarly, individual species may be known by multiple common names. Such inconsistent use of names can have significant implications for managing stocks, especially since collection of some is restricted or prohibited. Furthermore, we also determined that indigenous and non-indigenous biodiversity of the bait worms have undoubtedly been underestimated; we detected evidence of cryptic species (species that are genetically distinct but morphologically identical), while *Marphysa corallina* (wonderworm), *Scoletoma tetraura* (pudding worm) and *Diopatra aciculata* (moonshine worm) were not originally described from southern Africa and may either be non-indigenous, or unrecognised indigenous species. This investigation has emphasised that taxonomy of polychaetes in South Africa is not as well resolved as previously believed, and that much still needs to be done to gain a full understanding of the diversity of this important taxon. – *Prof CA Simon*

Selection of bait worms collected by fishermen in the Western Cape Province; Moonshine worms A) *Diopatra aciculata,* collected in Knysna, but originally described in Australia, and B) *Heptaceras quinquedens,* collected in Strand, Pearly Beach and Struisbaai, originally described from Zululand, and Pudding worm C) *Scoletoma* species A, collected from Betty's Bay, and one of two species that are morphologically almost indistinguishable from each other. *Photos: Carol Simon*

The role of plants in carbon cycle and climate uncertainties

Roughly one third of all additional greenhouse gas emissions from fossil fuel use have been absorbed by plants on land. This free ecosystem service is buffering the world from faster warming and more extreme climate change. Climate scientists and ecologists do not now know which ecosystems are responsible for this buffering effect, but increasingly, evidence suggests that a significant sink is to be found in the world's drylands, such as southern Africa savannas and semi-deserts. The Global Change Biology Group is participating and leading in a set of projects to reduce these uncertainties. In collaboration with the Enhanced Freshwater and Terrestrial Environmental Observation Network (EFTEON) and Bayreuth University in Germany, we aim to better understand the strength of the ecosystem "sink" for carbon in southern Africa, and how land use

affects the sink. Experiments and intensive monitoring using a range of data-logging equipment, combined with regular field work at a number of sites across semi-arid southern Africa, is starting to explore the critical question of how biodiversity contributes to the functioning of an ecosystem. – *Prof Guy Midgley*

Technical staff installed a CO_2 and H_2O flux measurement system in an arid Savanna/Karroid shrubland mozaic, Benfontein, Kimberley. *Photo: Amukelani Maluleke and Gregor Feig*

RESEARCH ACTIVITIES

Prof Anton Pauw delivered a keynote address at the 43rd New Phytologist Symposium on Interaction Networks and Trait Evolution in Zurich. The title of his address was "Long-legged bees make adaptive leaps: linking adaptation to coevolution in a plant–pollinator network".

Prof Sophie von der Heyden was invited as a keynote speaker at the Society for Molecular Biology and Evolution in Malawi with a talk entitled "Utilising genetic and genomic resources to help conserve Africa's biodiversity". She was also elected chair of the SANCOR steering committee for the period 2018-2019. SANCOR promotes marine research in South Africa and beyond.

Prof Conrad Matthee was invited to present his talk "Parasite evolution: who is getting on the boat?" as the opening talk in the session Taxonomy, Systematics and Evolutionary Biology at the congress of the Zoological Society of South Africa (ZSSA) in the Kruger National Park.

Prof John Measey gave the plenary address, entitiled "The future of our planet's amphibians and reptiles: a view from invasion science", at the 20th meeting of the Society for European Herpetology in Milan. He also gave an invited talk at the 9th Brazilian Congress of Herpetology, entitiled "Invasive amphibians: a view from southern Africa on opportunities and insights".

Prof Nox Makunga gave a keynote address at the The Belt and Road International Symposium on the Industrial Development of Traditional Medicine in China.

SERVICE TO THE SCIENTIFIC COMMUNITY

Prof Bruce Anderson is associate editor of *Proceedings of the Royal Society B* and the *Journal of Pollination Ecology*.

Prof Mike Cherry serves on the steering committee of the Centre of Excellence at the Percy FitzPatrick Institute. He is also associate editor of *Emu*.

Prof Susana Clusella-Trullas is handling editor of *Functional Ecology* and subject editor of *Ecography*.

Prof Leanne Dreyer serves on the editorial board of *Botany Letters*.

Prof Allan Ellis is associate editor of the *Botanical Journal of the Linnean Society*.

Prof Nox Makunga acts as associate editor for *Plant Tissue* and *Organ Culture*, and the two journals *e-Food* and *Food Frontiers*.

Prof Conrad Matthee is associate editor of *Molecular Phylogenetics* and *Evolution* and the *African Journal of Marine Science*. He also serves on the editorial board of *Koedoe*.

Prof John Measey led a postgraduate course, Invasion Science for Society: hands-on experience of environmental, social and economic impacts of alien species in July 2019. He is also academic editor of *PeerJ*, an open-access peer-reviewed scientific mega journal covering research in the biological and medical sciences, and associate editor for the journals *Salamandra*, *Bioinvasion Records* and *Herpetological Conservation and Biology*.

Prof Guy Midgley is involved with several national and international policy relevant projects in the field of biodiversity and climate change, including lead author for the 6th assessment report of the Intergovernmental Panel on Climate Change (IPCC), due to complete its work in 2021.

Dr Victor Rambau is associate editor of *African Zoology*.

Dr Tammy Robinson-Smythe presented, together with postdoctoral fellow Dr Koebraa Peters, two workshops on fouling of recreational yachts. The target group was sailors, marina managers and yacht maintenance companies. She is also associate editor of the journals: *Aquatic Invasions* and *Bioinvasion Records*.

Prof Dave Richardson is associate editor of *Forest Ecosystems* and *Neobiota* and serves on the editorial advisory board of *Frontiers of Biogeography* and *AoB PLANTS*. He is an editorial board member for two book series for Cambridge University Press: *Ecology, Biodiversity and Conservation* and *Conservation Biology*.

Prof Carol Simon is co-editor in chief of *African Zoology*.

Prof Sophie von der Heyden hosted the first eDNA workshop in Africa. She is associate editor for *Frontiers in Marine Science*, *Frontiers for Young Minds* and *Estuarine, Coastal and Shelf Science*.

Prof Brian van Wilgen is the lead editor on the book *Biological Invasions in South Africa* to be published in 2020.

Prof John Wilson presented an international workshop on Frameworks used in Invasion Science. He is assiciate editor of *Neobiota*.

Prof Theresa Wossler is co-editor-in-chief of *African Zoology*.

ACADEMIC AFFAIRS

The first-year module, Biology 124, is in the process of being developed into a Mode 2 delivery module for Bioinformatics honours students and may also be used for undergraduate students in future. Dr Marnel Mouton and Prof Allan Ellis are involved in this new initiative. The BioExcel support programme is developed further each year and serves as learning support for first-year biology students. This platform also provides a valuable training opportunity for tutors to become future academics and lecturers with a scholarly approach. Dr Marnel Mouton is a member of the Legitimation Code Theory group on campus working on a Science Education book for Routledge and has a strong collaboration with the Legitimation Code Theory Centre at Sydney University, Australia. Prof Theresa Wossler, Prof Allan Ellis, Dr Alex Flemming and Dr Marnel Mouton form part of a curriculum renewal task team to rethink curriculum and its delivery within the Faculty of Science.

Dr Mouton received an SU's University Capacity Development grant to further her research in teaching initiatives, having published a paper in 2019 focussing on first-year biology curriculum design and delivery. Drs Mouton and Ilse Rootman-Le Grange won the best research-based paper, "Craig Who? Developing students' scientific discourse through collaborative pedagogy", at the 2019 Scholarship of Teaching and Learning (SoTL) Conference. Dr Mouton also attended the Third Legitimation Code Theory conference in Johannesburg and presented two talks on first-year biology curriculum design and delivery.

During 2019 the Department had 12 BScHons students, 34 MSc students, 39 PhD students and 33 postdoctoral fellows.

NRF-RATED RESEARCHERS		
Leading international researchers	Prof GF Midgley	Ecology and ecophysiology
	Prof DM Richardson	Biological invasions and conservation biogeography
Internationally acclaimed researchers	Prof BA Anderson	Plant-animal interactions
	Prof MI Cherry	Behavioural ecology
	Prof S Daniels	Molecular systematics, phylogeography and conservation of invertebrates
	Prof AG Ellis	Evolutionary ecology of plants and insects
	Prof CA Matthee	Molecular systematics and phylogeography
	Prof CA Pauw	Evolutionary ecology of plants and their pollinators
Established researchers	Prof S Clusella-Trullas	Thermal adaptation of ectotherms and implications for climate change
	Prof LL Dreyer	Evolution of Cape Flora
	Prof NP Makunga	Medicinal plant bio technology
	Dr TB Robinson	Drivers, patterns and impacts of marine invasions
	Dr CA Simon	Marine invertebrate; reproduction and polychaete worm taxonomy
	Prof AJ Valentine	Molecular physiology of host microbe interactions of legumes in phosphorus deficient soils
	Prof S von der Heyden	Marine molecular ecology and conservation

FUNDING

The Department generated R9.34 million in outside research funding for 2019. Newly awarded grants in 2019 included NRF Marine and Coastal Research grants to Dr Tammy Robinson and Prof Sophie von der Heyden, an NRF Competitive Rated Researcher grant to Prof Carol Simon, an NRF Foundational Biodiversity Information Programme grant to Prof Sophie von der Heyden and the NRF Global Change Grand Challenge grant to Prof Guy Midgley. An NRF trilateral joint research collaborative grant (SA-Mozambique-Zambia) was secured by Prof Sophie von der Heyden, Prof Allan Ellis received an international collaborative grant through the Belgium Directorate-general Development (Belgium-UKZN-Stellenbosch University), while Prof Anton Pauw secured National Geographic funding for the Ingcungcu Project. Other funding agencies included the Royal Museum of Central Africa grant awarded to Prof Allan Ellis, an Oppenheimer Memorial Trust Grant to Prof Savel Daniels, Wild Bird Trust funding went to Prof Sophie von der Heyden, Prof Guy Midgley was funded through the Cambridge Conservation Initiative, Grootbos Foundation funding was obtained by Prof Theresa Wossler. TIA seed funding was awarded to Dr Corneile Minnaar and Prof Susana Clusella-Trullas was awarded an HB and MJ Thom Sabbatical grant.

FUNDING

South Africa

Escom Annual Koeberg Monitoring
Green Climate Fund (SPARC)
Grootbos Foundation
HB and MJ Thom
National Research Foundation
Oppenheimer Memorial Trust
Rhodes University
Royal Museum of Central Africa
SA Berry Producers
South African National Biodiversity Institute
Stellenbosch University
Technology Innovation Agency
Wild Bird Trust

International

Belgium Directorate-general Development Cooperation
Cambridge Conservation Institute
Centre for Agriculture and Bioscience International (CABI)
Human Frontier Science Program
National Geographic

COLLABORATION

Australia

Monash University
University of Sydney

Belgium

Ghent University

Canada

McGill University
McMaster University Hamilton
University of Toronto

Chile

Universidad de Austral
Universidad de Concepción
Universidad de la Frontera

France

Museum national d'histoire naturelle
University of Montpellier

Germany

University of Bayreuth
University of Frankfurt
Zoologisches Forschungsmuseum Alexander Koenig

Japan

Iwate University
University of Tohoku

South Africa

Cape Peninsula University of Technology
CSIR
Department of Environment, Forestry and Fisheries
Durban Natural Science Museum
East London Museum
Nelson Mandela University
Rhodes University
SANBI
Sol Plaatje University
South African institution of Aquatic Biodiversity
University of Cape Town
University of the Free State
University of Johannesburg
University of KwaZulu-Natal
University of Pretoria
University of the Western Cape

Switzerland

University of Fribourg
University of Lausanne

United States of America

Harvard University
Hofstra University
Northern Michigan
Trinity College
University of Arizona
University of California
University of Florida
University of Hawaii
Virginia Commonwealth University
Washington University

United Kingdom/Ireland

Cambridge University
Oxford University
University of Leeds
University of Liverpool
University College Dublin
University College London
University of St Andrews
University of the West of Scotland

Other

Charles University, Prague, Czech Republic
Federal University of Paraná, Brazil
Graphic Era University, India
ISPRA, Rome, Italy
National University of Singapore
University of Eduardo Mondlane, Mozambique
University of Hong Kong
Universidad Nacional del Litoral Santa Fe, Argentina
Universidad Pablo de Olavida, Spain
University of Vienna, Austria
Waginingen University, The Netherlands

AWARDS TO STAFF AND STUDENTS

Dr Sarah Andreotti, postdoctoral fellow and a director of the SharkSafe Barrier™ company, won the Nedbank ssociated Chairperson's Business Excellence Award 2019 at a function hosted by the Italian-South African Chamber of Trade and Industries. The award was in recognition of her role in developing the company towards full scale commercialisation. The SharkSafe Barrier was also named as one of the top three inventions of the last decade in the Business Insider. She also received a

Thought Leader award for media coverage about the SharkSafe Barrier and her research.

Aaron Barnes, an MSc student of Prof Savel Daniels, was awarded the Lawrence Memorial Grant through the Zoological Society of SA to promote research on litter/edaphic fauna of the forest floor.

Jolene Brooks, an MSc student of Prof Nox Makunga, was awarded the best oral presentation by a young scientist at the 4th International Conference on Natural Product Utilisation in Bulgaria, making her the youngest participant ever to receive the award.

Molly Czachur was awarded an FSBI Highly Commended prize for contributions to outreach related to activities during the annual symposium of the Fisheries Society of the British Isles (FSBI).

Dr Taina Loureiro, a postdoctoral fellow hosted by Dr Tammy Robinson, won the first prize for the best presentation at the Stellenbosch University Postgraduate Research Day, while **Erica Nielsen**, a PhD-student of Prof Clusella-Trullas, won the award for the best oral presentation at the same event.

Prof John Measey received a 2019 SU Research Excellence Award for the number of research outputs and number of research output units.

Prof Guy Midgley was awarded the prestigious Humboldt Research Award from the Alexander von Humboldt Foundation in Germany, as well as the Alexander von Humboldt Foundation Research Award for lifetime contribution to science. He also received recognition as a Thought Leader for his contributions to the media about climate change.

Dr Corneile Minnaar was the recipient of the Vice-Rector Postdoctoral Fellow Top 20 awards.

Monika Moir, a PhD student of Dr Victor Rambau, was awarded the best PhD presentation at the 39th ZSSA congress in the Kruger National Park.

Dr Marnel Mouton received the Rector's Award for Excellence in Teaching. She also won the award for the best research-based paper at the 2019 Scholarship of Teaching and Learning (SoTL) Conference, hosted by Stellenbosch University.

Prof Dave Richardson was the recipient of the African Union Kwame Nkrumah Award for Scientific Excellence in recognition of his major contributions to invasion science. His A1-rating from SA's National Research Foundation was also renewed until 2024.

Prof Carol Simon won the bid for SU to host the International Polychaete Conference in 2022 and was elected president of the International Polychaete Association.

Dr Luther van der Mescht received a media coverage award from SU for his project on the cat-fleas.

Namita Vanmali, an MSc student of Prof Guy Midgley, was awarded the best student presentation at the Fynbos Forum.

STAFF MATTERS

Dr Nasreen Peer was newly appointed as a lecturer, Ms Carrin Nel as administrative officer and Ms Megan Mathese was appointed as a technical assistant in 2019. Prof Bruce Anderson and Prof Allan Ellis were promoted to full professors, while Dr Tammy Robinson-Smythe was promoted to Associate Professor and Dr Marnel Mouton to Senior Lecturer, all effective January 2020.

Prof Hannes van Wyk retired, having started working at SU in 1979. The Department also had to greet Mr Moses Siebritz who resigned in November 2019.

STAFF LIST

Academic

Prof BA Anderson
Prof MI Cherry
Prof S Clusella-Trullas
Prof SR Daniels
Prof LL Dreyer
Prof AG Ellis
Dr AF Flemming
Prof NP Makunga
Prof CA Matthee
Prof GF Midgley
Dr M Mouton
Prof CA Pauw
Dr N Peer (New Appointment in 2019)
Dr VR Rambau
Prof DM Richardson
Dr TB Robinson
Dr CA Simon
Prof AJ Valentine
Prof HJ Van Wyk (Retired Decemeber 2019)
Prof S von der Heyden
Prof TC Wossler

Academic staff: Centre of Excellence for Invasion Biology

Dr S Kumchick
Prof J Measey
Prof J Wilson (Extraordinary professor)
Prof B van Wilgen (Emeritus professor)

Extraordinary professors

Prof W Przybylowicz
Prof J Przybylowicz
Prof W Foden
Prof L Foxcroft
Prof JR Wilson

Emeritus professors

Prof D Baird
Prof J Gilomee
Prof JAJ Nel
Prof AJ Reinecke
Prof SA Reinecke
Prof TJ Robinson
Prof DE van Dijk
Prof VR Smith

Support staff

Ms J Basson
Ms F Gordon
Ms S Jacobs
Ms S Johnson
Ms DJD Julies
Ms J Law-Brown
Ms MJ Mathese (newly appointed in 2019)
Ms AC Nel (newly appointed in 2019)
Mr R Robertson
Ms MP Sauerman
Mr M Siebritz (Resigned November 2019)
Mr N Solomons
Mr JP Williams
Mr H Witbooi

Support staff: Centre of Excellence for Invasion Biology

Mr E Basson (newly appointed 2019)
Ms L Cilliers (resigned 2019)
Ms K Coombe-Davis
Dr S Davies
D du Plessis
Ms S Kritzinger-Klopper
Ms J Lategan (newly appointed 2019)
Dr E Marais
Ms C Momberg
Ms R Moses (resigned 2019)
Ms L Msomi
Ms E Nortjé
Ms S Turner (resigned 2019)
Ms M van der Vyver

Postdoctoral fellows

Dr S Andreotti
Dr WJ Augustyn
Dr JH Baxter-Gilbert
Dr H Beckett
Dr JM Da Silva
Dr A Datta
Dr ML De Jager
Dr R Garcia
Dr T Goncalves Loureiro
Dr T Gridley
Dr DT Guzha
Dr H Hirsch
Dr JA Kara
Dr JH Keet
Dr B Loedolff
Dr M Mairal Pisa
Dr NA Masondo
Dr IA Minnaar
Dr C Minnaar
Dr NP Mohanty
Dr NP Mothapo
Dr T Musvuugwa
DR MM Nsikani
Dr K Peters
Dr NL Phair
Dr RJG Pierron
Dr J Riley
Dr N Stevens
Dr KP Thirupathi
Dr JC Truter
Dr L Van Der Mescht
Dr FA Yannelli Lucero
Dr J Zeyl

SOCIAL IMPACT

The Ingcungcu Project

The Ingcungcu Project aims to build a sunbird corridor across the City of Cape Town by planting indigenous gardens of nectar-rich plants at schools, which act as 'filling stations' for birds and outdoor classrooms for learners. The project's foundation rests on three interdependent pillars: research, restoration, and education, which combined aim to

Aloe arboresence in full bloom in an Ingcungcu garden at Levana Primary School - June 2019. *Photo: Anton Pauw*

connect plants, birds and people in under-resourced areas in Cape Town, South Africa. The funds received for the project have gone towards planting, maintaining and monitoring indigenous gardens in schools, taking learners on field-trips to local reserves and purchasing field equipment for learners to use.

To date, the Ingcungcu Project has:

- Planted eight indigenous gardens, containing more than 4000 plants of carefully selected nectar-rich species at under-resourced schools in Cape Town.
- Engaged more than 600 learners and 50 teachers in workshops, planting days, field-trips and camps.
- Measured the success and impact of these gardens through four years of monthly bird-count data at each of the eight schools. This data are currently being analysed and written up in a scientific paper.
- Developed active partnerships with 11 local organisations, institutes and small businesses which support the project in various ways: through knowledge and expertise, shared resources, access to networks, and above all a shared vision to connect people with nature, repair fragmented urban landscapes, and strengthen social and ecological resilience.

Learners from Steenberg Primary School on a birding field-trip to Rondevlei Nature Reserve, learning to use binoculars with volunteers from the Cape Bird Club - May 2019. *Photo: Anton Pauw*

The next stage of the journey for the Ingcungcu Project is to strengthen the three core elements of the project, namely science, restoration and education; formalise the organisational structure in order to register as an NPO, which will enable the expansion of the team; continue to grow our network of partners, collaborators and supporters to deepen and expand our impact; expand to new schools in order to extend the ecological corridor across the fragmented urban landscape of Cape Town; and to build a long-term mentorship program with our partners to nurture the biodiversity leaders of the future.
– Prof Anton Pauw

Art-meets-Biology initiative

Dating back to prehistoric cave drawings and body ornamentation, nature has always been and will always be a driving force of creative inspiration. Our Department has an extensive collection of plant and animal specimens, and these have been loaned and photographed, painted or drawn by many artists (students or professional) over the years. More recently, in collaboration with Art Centers in the Stellenbosch and Helderberg areas, we have introduced practical sessions to allow primary and secondary school learners to make use of our collections for creating artwork. These sessions take place on Saturdays in one of our undergraduate laboratories.

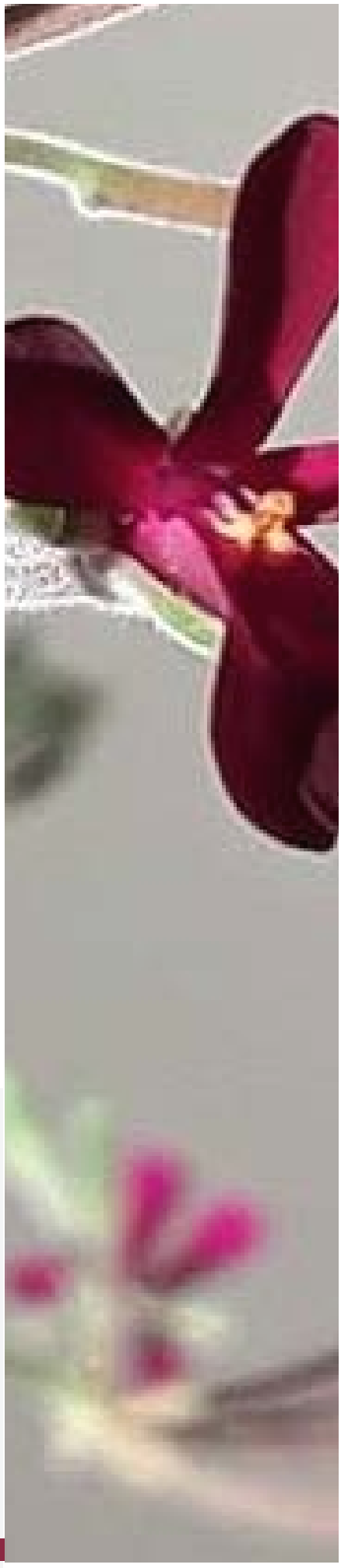
Nature inspires art, but conversely, art can also aid biological understanding. For this reason, we have introduced a workshop specifically on Biological Illustration for Grade 11 and 12 learners from the PJ Oliver Art Centre, Stellenbosch. Learners are introduced to various techniques in scientific illustration, and then have to create an artwork through a printmaking method of their choice.

Art education remains extremely marginalised in South African public schools. At present, it falls under the broader subject of "creative arts" in the primary and secondary school curricula, and is compulsory for all pupils up to Grade 9. After that, there is little or no formal emphasis on the subject. Many schools do not have suitably qualified teachers to facilitate quality art education. In higher income areas, learners are often enrolled at Art Centres, such as the ones mentioned above, for better quality education. The Art-meets-Biology Initiative is in operation for four years, and we would like to extend this to lower income and under-performing schools in future. – *Mindi Flemming*

Gardens and their many healing properties

Prof Nox Makunga was invited as a brand ambassador to participate in Garden Day 2018-2019, which is now hosted in South Africa during the third week of October. Garden Day is an initiative that allows all South Africans to take a break and enjoy the day with friends, family, gardeners and other plant lovers to enjoy the fruits of their own gardens, community gardens and other green public spaces. Before and on Garden Day, public engagement and science communication is driven through various social media platforms, radio and television interviews. For Prof Makunga the highlight was the interview on the television magazine program Afternoon Express in September by Jeannie D on the benefits of gardens; how to start a healing garden plus which medicinal plants are important in a healing garden. Also, she contributed to an article in SA *Glamour* magazine discussing the benefits of medicinal plants in skin care products.

Prof Makunga was also invited to give a public talk on 20 October 2019 entitled 'Healing gardens and the power of medical plants for health' at the Kalk Bay garden shop. Using her 'box of tricks' full of Cape medicinal plants, she discussed her research on how medicinal plant chemistry allows plants to respond to the environment, touched on the ethnobotanical practices of healer communities in the Western Cape and shared her latest research on plants with interesting pharmacological bioactivities that will hopefully enter into the phytopharmaceutics industries in the future. Apart from sharing her research on medicinal plants of the Cape, she wore a flower crown, joining in the spirit of the day.



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DEPARTMENT OF CHEMISTRY AND POLYMER SCIENCE

RESEARCH INTERESTS

Organic and medicinal chemistry
Inorganic and organometallic chemistry
Analytical chemistry
Polymer science
Physical and computational chemistry
Supramolecular and materials chemistry
Chemistry education

RESEARCH HIGHLIGHTS

Amphiphilic copolymers for the isolation of membrane proteins

About a decade ago, the previously greatly problematic isolation of membrane proteins (MPs) received a significant boost through the application of poly(styrene-*co*-maleic acid) (SMA) with a styrene to maleic acid ratio of two and relatively low molar mass. The formation of SMA stabilized phospholipid nanodiscs (SMALPs), which are essential in the new method for isolation of MPs, has received a lot of attention in recent years. A commercial SMA product (SMA2000), synthesized via conventional radical polymerization, is currently the gold standard, but it has been shown that also poly(diisobutylene-*alt*-maleic acid) (DIBMA) is able to create the nanodiscs. Again, a commercial product (Sokolan CP9) is widely used among researchers in this application. Over the past years we have set out to synthesize SMA and DIBMA versions with a narrow molar mass distribution. In collaborations with the University of Birmingham (Prof TR Dafforn) and Utrecht University (Prof JA Killian), we investigated the role of average molar mass and width of the molar mass distribution on the formation of SMALPs and on the isolation of MPs. Two publications about DIBMA and SMA, respectively, are currently in preparation in which the role of molar mass is studied in greater detail than has been possible until now.

– Prof Bert Klumperman

Drug delivery for parasitic diseases

In a BRICS funded project, we are collaborating with the groups of Prof V Mosqueira (Federal University of Ouro Preto, Brazil) and Prof F Meng (Soochow University, China) on the development of drug delivery methods for drugs against less known parasitic diseases such as Chagas disease and Leishmaniasis. From the Stellenbosch side we are investigating the role of the surface characteristics of nanoparticles in their uptake behavior by mammalian cells. To that end, nanoparticles with variable and well-defined surface characteristics have been synthesized and chemically analyzed. Two SU students visited the collaborator in Brazil and performed an extensive sets of experiments in order to identify the rate and mechanism of uptake of the nanoparticles by cells depending on the surface characteristics of the nanoparticles. One MSc student has graduated based on the work done in this collaborative project.

– Prof Bert Klumperman

Phase behaviour of molecular brushes

Molecular brushes are densely grafted copolymers that possess properties that largely result from the topology of the molecules. Due to the high grafting density, the backbone of such molecular brushes is close to fully stretched. We synthesized molecular brushes from two different macromonomers, to create an amphiphilic molecular brush in which the hydrophilic (poly(ethylene glycol), PEG) and the hydrophobic (long chain alkyl) are placed in an alternating fashion along the backbone.

After chemical characterization, the behavior of the molecular brushes was investigated in a selective solvent (water) for the hydrophilic grafts. It turned out that the brushes self-assemble into elongated structures in order to minimize exposure of the hydrophobic grafts to the aqueous phase. In collaboration with Prof A Mueller (University of the Basque Country, Spain) we further investigated the behavior of the molecular brushes in the condensed phase. Above a certain chain length of the grafts, PEG and the alkyl chains have the ability to crystallize. Interesting phenomena were discovered related to the limited mobility of the grafts and their tendency to crystallize. The observation of spherulites upon crystallization of the molecular brushes is quite a remarkable one in view of the normal way that polymer crystallization takes place. The orientation of molecular brushes in the spherulites is the subject of further investigations in our group. The abovementioned collaboration with Prof Mueller is part of an EU-sponsored RISE (Research and Innovation Staff Exchange) project namely BIODEST (Synthesis, Characterisation, Structure and Properties of Novel Biodegradable Polyesters).

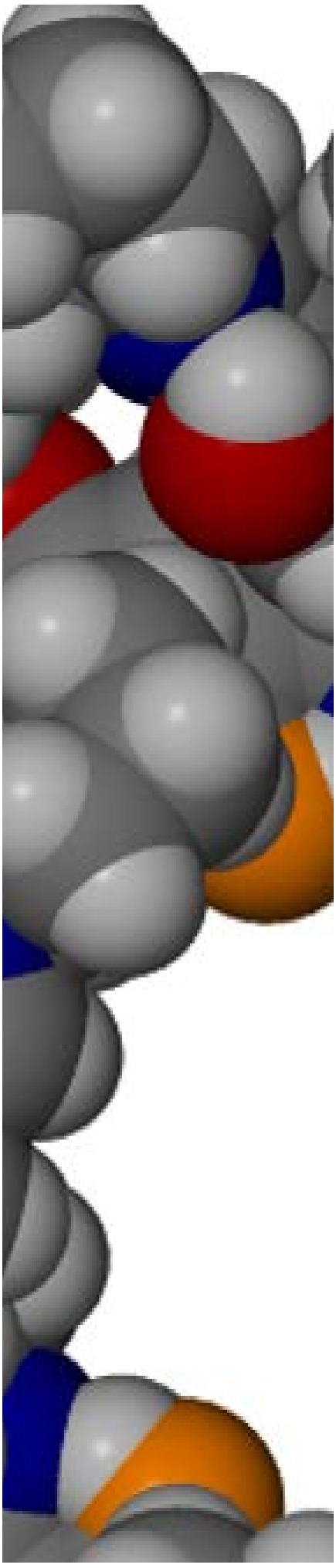
Under the umbrella of BIODEST, one PhD student has spent three months at the University of the Basque Country to investigate crystallization behavior of the molecular brushes. This joint activity has led to a publication that appeared early 2020 in *Macromolecules*. As part of the BIODEST program, Prof Klumperman and Dr Pfukwa visited a comprehensive review meeting of the program at the University of Mons in Belgium in 2019. – *Prof Bert Klumperman*

RESEARCH ACTIVITIES

Prof Gareth Arnott presented a keynote lecture at the Frank Warren conference held in the Drakensburg and an invited lecture at the 11th International Symposium on Nano and Supramolecular Chemistry held in Chizhou, China, on his work with inherently chiral calixarenes.

Prof Len Barbour presented plenary lectures at the Crystal Engineering Laboratory Technology and Innovation Conference (Killarney, Ireland) and at the 26th Croatian Meeting of Chemists and Chemical Engineers (Šibenik, Croatia). He presented a keynote lecture at the 24th International Conference on the Chemistry of the Organic Solid State (New York City, USA) and at Physical Properties of Metal-Organic Frameworks – A Nature Conference (Tianjin, China). He also presented invited lectures at the 14th International Symposium on Macrocyclic and Supramolecular Chemistry (Lecce, Italy), Visionary Trends in Molecular Science III - a one-day symposium in honour of Nobel Laureate Sir Fraser Stoddart (Tianjin University, Tianjin, China) and the Conference of Comprehensive Chemistry (Beijing Institute of Technology, China). Prof Barbour presented invited lectures at Zagreb University (Croatia), University of Science and Technology Beijing (China), Nankai University (Tianjin, China), and two at Rhodes University.

Dr Margaret Blackie presented a lecture entitled "Lonergan and LCT (Semantics) – Hope for chemistry education?" at the third Legitimation Code Theory conference held in Johannesburg. She also spoke at the South African Education Research Association (SAERA) conference in Durban with the theme "Science education for Africa", and contributed to the foundation of a Special Interest Group in LCT at the SAERA conference for Knowledge Building in Educational Practices. She visited Lancaster



University for a research group meeting with the Understanding Knowledge and Student Agency (UKSA) project team in November 2019. The project covers development of knowledge, study practices, orientation to society and identity formation in students of chemistry and chemical engineering. She was also invited twice to the School of Physics and Chemistry at the University of KwaZulu-Natal (UKZN) to give workshops in teaching and learning in 2019.

Prof Jan Dillen presented an invited lecture at the 18th European Symposium on Gas-phase Electron Diffraction that was held in Kleinwalserstal, Austria, 30 June-4 July 2019, and also at the 23rd International Conference on "Horizons in Hydrogen Bond Research" that took place from 24-27 September in Amsterdam.

Prof Delia Haynes was a visiting professor at the University of Warsaw's Biological and Chemical Research Centre in July 2019. Her visit was supported as part of the Centre's Visiting Professor Programme. She presented research and training seminars, and furthered her collaborative work with Prof Krzysztof Woźniak.

Prof André de Villiers presented a keynote lecture entitled "Incorporating ion mobility spectrometry into one- and two-dimensional LC-MS workflows for phenolic analysis" at the 48th International Symposium on High-Performance Liquid Phase Separations and Related Techniques (HPLC 2019) held from June 16-20 2019 in Milan, Italy. He was also invited to present an invited keynote lecture at the jointly organised 11th Symposium of Enology (Œno2019) and the 11th edition of In Vino Analytica Scientia (IVAS 2019) conference held from June 25-28 2019 in Bordeaux, France. The title of his presentation was "Multidimensional chromatography in grape and wine analysis".

Prof Catharine Esterhuysen presented a keynote lecture at the first International Conference on Noncovalent Interactions held in Lisbon, Portugal, from 2-6 September 2019.

Prof Delia Haynes gave a plenary lecture at the European Synchrotron Radiation Facility (ESRF) workshop in Johannesburg, November 2019, and two invited lectures at the 32nd European Crystallography Meeting in Vienna in August 2019: one on her research involving bonding, and one entitled "Women in Science – an African perspective". She attended a workshop on "Tools for chemical bonding", as well as a conference on charge density in Germany in July 2019. She gave an invited lecture at the first International Conference on Noncovalent Interactions held in Lisbon, Portugal, from 2-6 September 2019.

Prof Bert Klumperman presented an invited lecture at the SMALP (Styrene Maleic Acid Lipid Nanoparticles) meeting in Utrecht, the Netherlands, on 26 April 2019. He also gave an invited lecture at the Frontiers in Polymer Science Conference in Budapest, Hungary, from 5-8 May 2019. Prof Klumperman, Ms LE Ball and Ms ACP Cronjé attended the annual BRICS project progress meeting at the Federal University of Ouro Preto, Brazil, from 2-4 December 2019.

Dr Rehana Malgas-Enus gave an oral presentation at the South African Chemical Institute (SACI) New Chemists on the Block Symposium, Cape Town, 4 April 2019, as well as a keynote lecture at the SU Postdoc Research Day Forum (October 2019, Stellenbosch) and a keynote at the Women in Maths symposium (August 2019, Cape Town). She also attended the American Association for the Advancement of Science (AAAS 2019) conference in Washington, DC (February 2019), as part of her NRF Excellence in Science Engagement Award.

Prof Peter Mallon presented a keynote lecture at the POLY-CHAR 2019 Conference in Nepal in May.

Prof Willem van Otterlo presented an invited lecture at the Markovnikov Congress on Organic Chemistry (MC150), University of Kazan, Kazan, Russia, as part of celebrations involving the 150th anniversary of the scientist Markovnikov's achievements at his home university. He also presented invited lectures at the National Cancer Institute (NCI), Frederick, USA, and at the Universities of Cologne and Leipzig, Germany.

SERVICE TO THE SCIENTIFIC COMMUNITY

Prof Gareth Arnott has served on the NRF rating committee for Chemistry since 2018. He is a member of the organising committee of the 2021 South African Chemistry Institute (SACI) National Convention and sits on the Western Cape SACI Committee.

Prof Len Barbour served as an Associate Editor of the *New Journal of Chemistry,* published by the Royal Society of Chemistry. He is on the editorial advisory boards of *CrystEngComm* (RSC) and *ACS Sustainable Chemistry and Engineering.*

Dr Margaret Blackie served on the International Conference on Chemistry Education (ICCE2020) conference committee. She is also treasurer of the SACI Western Cape division.

Prof André de Villiers serves as chair of the Western Cape division of the Chromatographic Society of South Africa (ChromSA). In this capacity, he also serves as the conference chair for the upcoming ChromSAAMS conference, to be held in 2021 at STIAS, Stellenbosch. He is also a member of the Editorial Advisory Boards of the *Journal of Chromatography, Chromatographia* and *LCGC.*

Prof Catharine Esterhuysen is currently chair of the South African National Committee of the International Union of Crystallography and president of the South African Crystallographic Society. She is a member of the International Programme Committee for the xxv General Assembly and Congress of the International Union of Crystallography (IUCr 2020).

Prof Delia Haynes was elected as chair of the Executive of the Steering Committee for the African Crystallographic Association. She is also a member of the SACI Western Cape committee, and gave a public lecture for the International Year of the Periodic Table at UWC in November 2019.

Prof Bert Klumperman chaired the 13th International Conference on Advanced Polymers via Macromolecular Engineering (APME2019), which was held at STIAS, Stellenbosch, from 14-18 April 2019. Prof Klumperman was an editor for Elsevier's *European Polymer Journal* until 30 September 2019, after which he assumed an Associate Editorship of *Macromolecules* (ACS) on 1 October 2019. Prof Klumperman is the Editor-in-Chief of *Transactions of the Royal Society of South Africa* and a member of the Council of the Royal Society of South Africa.

Dr Robbie Luckay presented a lecture on Electrochemistry to a group of about 100 teachers in the Western Cape.

Prof Peter Mallon led the South African delegation to the General Assembly of the International Union of Pure and Applied Chemistry (IUPAC) meeting in Paris, France, in July 2019 in his capacity as the Chair of the South African IUPAC committee. He was elected as a permanent member on the IUPAC Polymer Division Subcommittee on Polymer Terminology (SPT). He also represented the South African Chemical Institute at the Chemical Societies Presidents' Forum hosted by the Société Chimique de France (French Chemical Society) in Paris. At this meeting, the Presidents of 15 international chemical societies signed the joint framework agreement on the United Nations Sustainable Development goals. This agreement states the importance of Chemistry in addressing many of the goals and commits the societies to work together in achieving these goals. Prof Mallon was elected as the President of the South African Chemical Institute (SACI) for the 2019-2021 term.

Prof Willem van Otterlo (left) and Prof Peter Mallon were elected vice-president and president of the South African Chemical Institute (SACI) respectively, with PhD-student Megan Mathews (in the middle) as the national postgraduate representative on the council. *Photo: Stefan Els*

Prof Willem van Otterlo was elected as Vice-President of the South African Chemical Institute (SACI) for the 2019-2021 term. In addition, he was appointed as one of two Alexander von Humboldt (AvH) Ambassador Scientists for South Africa (2019-2022).

ACADEMIC AFFAIRS

NRF-RATED RESEARCHERS		
Leading international researchers	Prof Len Barbour	nanostructured functional materials
	Prof Bert Klumperman	living radical polymerization and advanced macromolecular architectures
Internationally acclaimed researchers	Prof Ben Burger	chemical communication in living organisms
	Prof Harald Pasch	analytical polymer science, multidimensional chromatography
	Prof Helgard Raubenheimer	ligand design aimed at applications in homogeneous catalysis, gold chemistry
	Prof Willem van Otterlo	organic synthesis and medicinal chemistry
	Prof André de Villiers	separation science fundamentals and applications
	Prof Klaus Koch	platinum group metals
Established researchers	Prof Catharine Esterhuysen	intermolecular interactions
	Prof Ivan Green	small molecule syntheses for medicinal application
	Prof Peter Mallon	complex polymer materials and polymer nano-composites
	Prof Selwyn Mapolie	homogeneous catalysis via dendrimeric complexes
	Prof Albert van Reenen	polyolefins
	Prof Jan Dillen	computational studies
	Dr Robbie Luckay	ligand design for metal ion coordination in industrial and medical applications
	Prof Delia Haynes	crystal engineering of non-metal containing materials
	Prof Gareth Arnott	inherently chiral calixarenes; asymmetric methodology
	Dr Katherine de Villiers	antimalarial agents

COLLABORATION

Austria
BOKU University
Belgium
Free University Brussels
University of Antwerp
University of Ghent
Brazil
Federal University of Ouro Preto
Cameroon
University of Yaoundé I
Canada
McGill University
University of Alberta
University of Waterloo
University of Windsor
China
Soochow University
Finland
Lapeeranta University
France
University of Lorraine
Germany
Leipzig University
Technical University Dortmund
Technical University Dresden
Italy
University Frederico II, Naples
Namibia
University of Namibia
Netherlands
University of Amsterdam
Utrecht University
Vrije Universiteit Amsterdam
Poland
University of Warsaw
Republic of Ireland
University of Limerick

South Africa
Cape Peninsula University of Technology
Council for Scientific and Industrial Research (CSIR)
Nelson Mandela University
North West University
Rhodes University
Stellenbosch University
University of Cape Town
University of Pretoria
University of the Western Cape
University of the Witwatersrand

United Kingdom
Lancaster University
University of Birmingham
University of Edinburgh

United States of America
Columbia University
Emory University
Georgetown University
Gustavus Adolphus College
Pennsylvania State University
Texas State University, San Marcos
University of North Carolina Wilmington
Virginia Tech

FUNDING

DST/NRF SARCHI Programme
National Research Foundation (NRF)
NRF National Equipment Programme
NRF-FWO (Research Foundation Flanders) bilateral programme
NRF Competitive Programme for Rated Researchers
NRF – Thuthuka Programme
SASOL
Restek
Stellenbosch University

AWARDS TO STAFF AND STUDENTS

Prof Catharine Esterhuysen was elected as a Fellow of the Royal Society of South Africa.

Ms Isabella Claassens won the first prize for her poster at the 10th Crystal Forms meeting in Bologna, Italy. She also won the International Union of Crystallography (IUCr) Journals Poster Prize at the First International School on Advanced Porous Materials (MOF School) in Como, Italy.

Prof Klaus Koch was the recipient of the South African Chemical Institute Gold Medal. He was formally presented with the medal (the highest award of the Institute) at a function in Cape Town in November 2019, shortly before he very sadly passed away in January 2020.

Prof Harald Pasch receiving the SCM Lifetime Achievement Award.
Photo supplied

Prof Harald Pasch received the SCM Lifetime Achievement Award for "for his massive contributions to the development of polymer characterization techniques". He received the award at the 9th International Symposium on the Separation and Characterisation of Natural and Synthetic Macromolecules (SCM-9) held in Amsterdam February 2019.

The late Prof Klaus Koch in 2014.
Photo: Wiida Fourie-Basson

Prof Gareth Arnott was a 2019 recipient of the Stellenbosch University Teaching Excellence Award. He received the award in the Developing Teacher category.

STAFF MATTERS

Prof Klaus Koch very sadly passed away at the end of 2019. Since joining the department in 2000 he has made an enormous contribution to the Department, including by serving as the first Executive Head of Department. He will be remembered as a great scientist and teacher.

Dr Gareth Arnott was promoted to Associate Professor from January 2019 and Dr Rehana Malgas-Enus was promoted to Senior Lecturer. Carla Pretorius was appointed as a lecturer from 1 September 2019. Faith de Vries joined the department as a Junior Technical Officer and Yolanda Mgqala took up her new position as a Principle Technical Assistant.

STAFF LIST

Academic staff

Research Chairs

Prof LJ Barbour
Prof B Klumperman
Prof H Pasch

Professors / Associate Professors

Prof GE Arnott
Prof AJ de Villiers
Prof JLM Dillen
Prof C Esterhuysen
Prof DA Haynes
Prof PE Mallon (Departmental Head)
Prof SF Mapolie
Prof WAL van Otterlo
Prof AJ van Reenen

Senior Lecturers / Lecturers

Dr MAL Blackie
Dr P Chellan
Dr K de Villiers
Dr WJ Gerber
Mrs A Gericke
Dr CH Kaschula
Dr T le Roex
Dr RC Luckay
Dr M Lutz
Dr R Malgas-Enus
Dr C Pretorius

Senior Researchers/Research associates / Fellows

Prof IR Green
Dr NP Gule
Dr R Pfukwa
Dr AGJ Tredoux

Extraordinary professors

Prof T Daffron
Prof A Lederer
Prof W Mackenroth

Emeritus professors

Prof BV Burger
Prof Klaus Koch
Prof HG Raubenheimer

Administrative staff

Mrs BR Chordnum
Mrs MMG Cooper
Mr MK Dludlu (Departmental Manager)
Ms M du Plessis
Mr JG Goldie
Mrs SG May
Mrs MC Snyman

Technical staff

Mr EJ Lukhele
Mr MG Marupula
Mr MA McLean
Ms Y Mgqala
Mr S Mohamed
Mr JS Motshweni
Mr A Nxopo
Dr H Pfukwa
Mrs PJ Steyn
Mr GR Willemse

Assistants

Ms F de Vries
Ms D Isaacs
Ms M Jones
Mr KB Mbalo
Ms CJ van Reenen
Mr MK Wakens
Ms DC Wenn

Postdoctoral fellows

Dr N Chaudhary
Dr Ps Eselem Bungu
Dr GH Greyling
Dr WA Hadasha
Dr A Hazra
Dr LE Hodson
Dr MAP Langlais
Dr L Loots
Dr S Mbizana
Dr A Ndiripo
Dr HA Nkabyo
Dr DD Robertson
Dr S Sanyal
Dr P Sikiti

SOCIAL IMPACT

Department of Chemistry and Polymer Science Outreach

During 2019, the SU Chemistry Outreach Initiative (SUNCOI) hosted three "Practicals with Purpose" events, enabling 350 Grade 11 and Grade 12 learners from disadvantaged schools to carry out their prescribed chemistry practical experiments in our fully equipped labs, as well as the Grade 12's from the SciMathUs programme. The practicals are assessed and form part of the learners' Physical Sciences year mark.

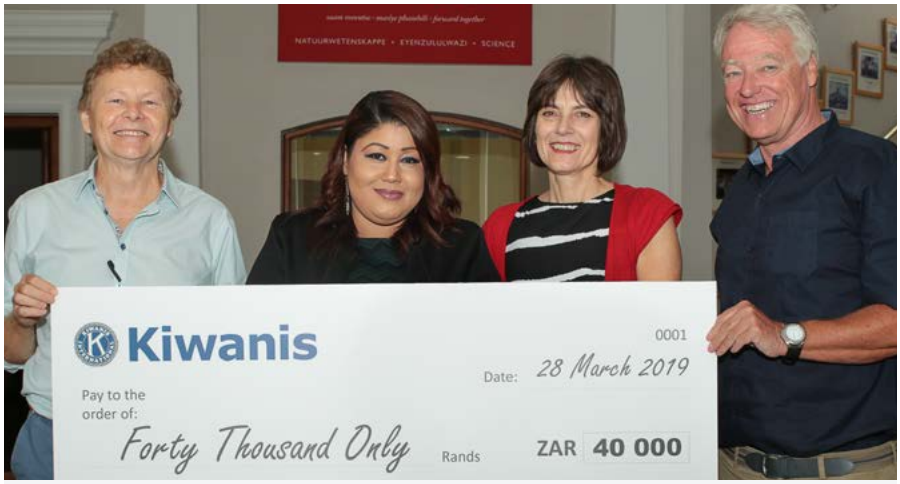
The workshops were made possible through a donation of R240 000 from the SBA (Stigting vir die Bemagtiging deur Afrikaans). To promote science, SUNCOI, in collaboration with the SBA, identify areas in need to host annual teachers' workshops. In 2018, teachers from 20 schools in the surrounding Matsikamma area were invited to a teachers' workshop hosted in the NG church hall in Vredendal. The teachers were trained to do 10 fun experiments and afterwards the SBA donated science kits to each of the schools to enable them to do the experiments in their own classrooms. The workshop was repeated in Leeu-Gamka, Western Cape. Dr Rehana Malgas-Enus launched a new Primary School science kit at this event, with eight experiments suitable for primary school learners, and SBA once again sponsored kits to all participating schools. These kits present an innovative way of engaging the youth and fostering a love for science.

The SBA (Stigting vir Bemagtiging deur Afrikaans) donation to the SU Chemistry Outreach Initiative (SUNCOI). From left to right, Prof Louise Warnich (dean: Faculty of Science), Mr Jabu Lukhele (Senior technical officer), Prof Rehana Malgas-Enus (Department of Chemistry and Polymer Science), and from the SBA Dr Mvula Yoyo and Mr Gerswin Cupido. Photo supplied

The Department also hosted our annual Physical Sciences Teachers' Workshop, for Physical Science teachers teaching Grades 10 to 12. During this period, we trained 90 teachers from 70 schools and four different education districts, enabling them to perform practical experiments in their under-resourced classrooms.

On 2 February 2018 the SUNCOI Satellite Project was launched in collaboration with the University of Pretoria (UP) and Nelson Mandela University (NMU). A licensing agreement was signed between the universities and UP-SUNCOI as well as NMU-SUNCOI was born. The launch of the SUNCOI Satellite programme plays a significant role, as the SUNCOI model has proven to be successful in the Western Cape area, hence more schools across South Africa will be able to benefit from this project by implementing the model at participating universities. Both UP and NMU has successfully hosted high school learners at their respective universities in 2019. We have seen the impact this has had on high school learners, and we believe that exposing them to tertiary institutions will encourage them to aim higher, despite their current circumstances. The post graduate chemistry students who volunteer to assist the learners, also act as role models, proving to the visiting learners that they too can study, if they are determined and have a good work ethic.

Prof Wolfgang Mackenroth, an extraordinary professor at SU, formerly associated with BASF Germany, collected R25 000 at his retirement party to donate to the SUNCOI programme. His NGO, Kiwanis, topped up the donation with another R15 000, and a cheque of R40 000 was handed over to SUNCOI in March 2019.



From left to right: Professor Klaus Koch, Dr Rehana Malgas-Enus, Prof Louise Warnich (Dean of Science) and Prof Wolfgang Mackenroth. *Photo: Anton Jordaan*

AlchemUS outreach activities

AlchemUS, the department's student society, presented their annual Magic Show to an audience of 236 school learners, as well as to a public audience. To celebrate the International Year of the Periodic Table, the theme for the show was Periodic Table-based. Prof Peter Mallon also gave a short talk on the importance of the Periodic Table. The show was followed by a presentation on the chemistry behind the magic by PhD student, Dewald van Heerden, where the science behind the experiments used in the show was explained.

Making science accessible

Dr Rehana Malgas-Enus and Prof Catharine Esterhuysen did an interview on Afrikaans radio station RSG, explaining the science behind hand sanitisers. Dr Rehana Malgas-Enus also had a radio interview with RADIO786, discussing the achievements of MSc student Gerbrandt Kotze, whose degree was collected by his mother posthumously, in December 2018.

CONTACT DETAILS

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Web: http://www.sun.ac.za/chemistry

DEPARTMENT OF EARTH SCIENCES

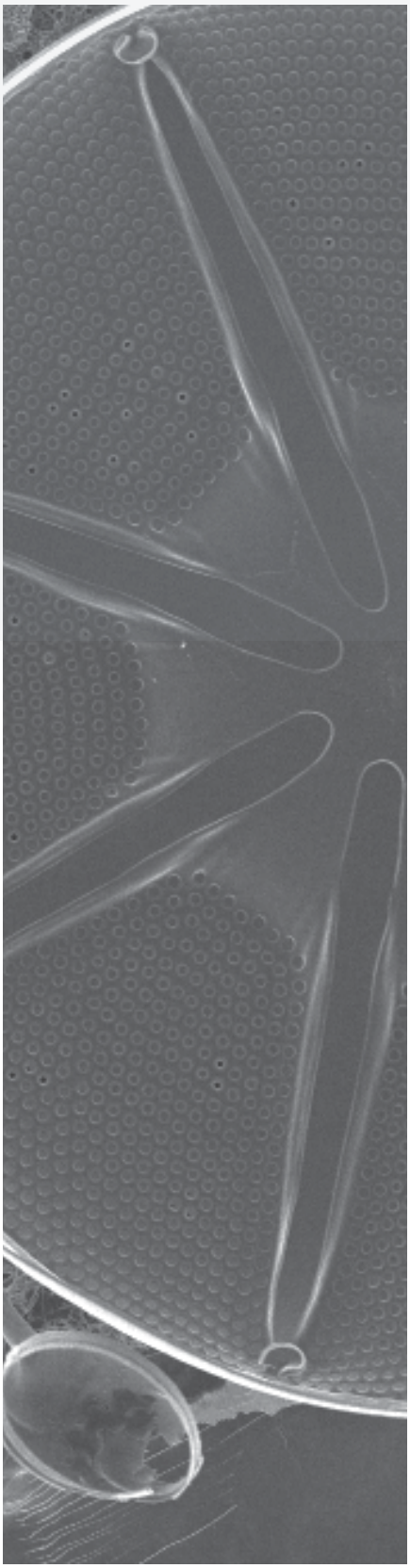
RESEARCH INTERESTS

Geology

Tectonics and orogenic processes
Archean geology
Sedimentology and palaeontology
Igneous petrogenesis
Metamorphic petrology
Experimental petrology
Controls of hydrothermal precious- and base-metal mineralisation
Heavy mineral deposits
Geometallurgy

Environmental geochemistry

Trace-element and isotope geochemistry
Marine geochemistry
Hydro-geochemistry
Geohydrology
Environmental geochemistry
Isotope hydrology



RESEARCH HIGHLIGHTS

Fluid inclusion laboratory now up and running

The fluid inclusion microthermometry analysis unit is now up and running and is housed within the Department of Earth Sciences. Fluid inclusion analysis provides detailed insights into the thermochemical properties (e.g. temperature, salinity, etc.) of the fluids responsible for mineralising ore deposits in the Earth's crust. To date, the fluid inclusion laboratory has produced one MSc-student, and has augmented the insights and understanding attained through two further doctoral level investigations. It is envisaged that the lab will produce a continual output of high-level scientific publications.

– Dr B von der Heyden

Disentangling the controls on remote African gold mineralisation

PhD candidates Joshua Chisambi and Stephan Dunn have been undertaking detailed geological investigations of remote gold occurrences in Malawi and Tanzania respectively. Their investigations add meaningfully to our scientific understanding of these historically understudied regions of the Earth's crust, whilst simultaneously providing important insights that can be used to determine the feasibility of ultimately mining gold in these areas.

– Dr B von der Heyden

Beta version of Rcrust now available

In 2019 the Rcrust team released the Beta version of a range of new modules to their growing thermodynamic modelling toolkit. Most notably these include functions for the calculation of activities of chemical components, the setting of oxygen fugacity buffers and the beginnings of a module for trace element partitioning and accessory phase saturation.

– Dr Matthew Mayne

Pollution pathways project in Saldanha Bay

Postgraduate students in Earth Sciences and an MSc-student from the University of Pretoria started with the Saldanha Bay project. The aim of the project is to investigate the pollution pathways from soil to dust to water to sediment, as well as the impact on the ecosystem, starting with the microorganisms in order to improve remediation strategies. In December 2019, the HonBSc-students and PhD-student Ismael Kangueehi presented the outcomes of this year's research to the Saldanha Bay Intergovernmental Task Team.
– Dr Susanne Fietz

HonsBSc-student Andile Mkandla and PhD-student Ismael Kangueehi preparing to take the team's first soil samples in the Saldanha Bay area.

Photo: Susanne Fietz

Exploring the Southern Ocean

Postgraduate students participated in several ocean expeditions this year. The first one to sail was PhD candidate Asmita Singh who collected samples and conducted experiments on board the Norwegian Polar ice breaker, Kronprins Haakon, during the Dronnning-Maud-Land Autumn 2019 research cruise along the Antarctic ice shelf. As part of a joint collaboration between the Southern Ocean Climate and Carbon Observatory (SOCCO) at the CSIR and SU's Department of Earth Sciences, Singh assesses the impact of iron on phytoplankton photophysiology.

In July and August 2019, 12 postgraduate students and postdoctoral fellows joined the Winter Cruise into the Southern Ocean on board South Africa's flagship research vessel SA Agulhas II. They collected samples and conducted experiments to determine the distribution of trace nutrients in the Southern Ocean including the sea ice and assess their relationship with the ocean's microorganisms, e.g. the algae, key players in uptake of CO_2. In November 2019 a group of six postgraduate students joined the Spring Cruise on board the SA Agulhas II to assess seasonal dynamics. In addition, PhD candidate Johan Viljoen was invited to participate in the international Geotraces summer school on-board the Spanish Intermare school vessel in Cadiz. The summer school promotes a good understanding of the biogeochemical cycles of trace metals in the ocean. – *Dr Susanne Fietz*

Earth Science students participating in the SCALE Winter Cruise 2019, on-board the research vessel SA Agulhas II.

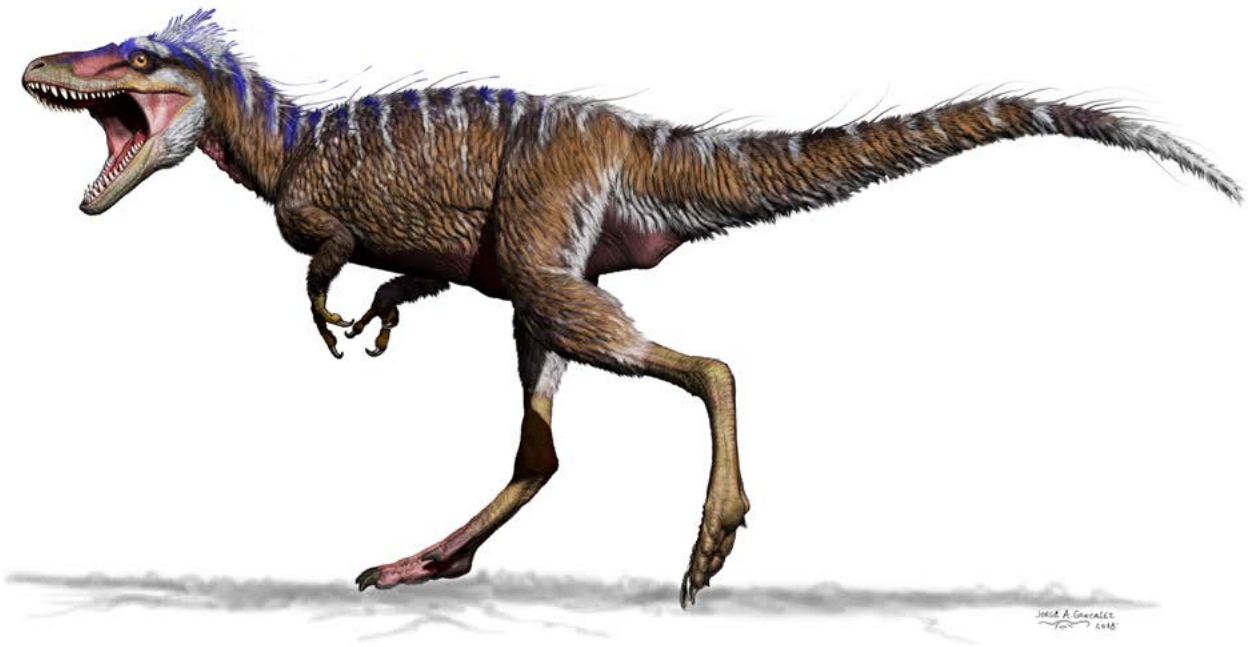
Photo: Susanne Fietz

NEW SPECIES OF TINY TYRANNOSAUR FORESHADOWS RISE OF T. REX

A newly discovered and diminutive relative of the tyrant king of dinosaurs reveals crucial new information about when and how *Tyrannosaur rex* came to rule the North American roost. *Moros intrepidus,* whose name means "harbinger of doom", is the oldest Cretaceous tyrannosaur species yet discovered in North America, narrowing a 70-million-year gap in the fossil record of tyrant dinosaurs on the continent.

Medium-sized, primitive tyrannosaurs have been found in North America dating from the Jurassic (around 150 million years ago). By the Cretaceous – around 81 million years ago – North American tyrannosaurs had become the enormous, iconic apex predators we know. The fossil record between these time periods has been a blank slate, preventing scientists from piecing together the story behind the ascent of tyrannosaurs in North America.

Dr Ryan Tucker was brought in as part of the team in 2015 to provide the geological context by radiometrically age-dating isotopes preserved within the zircon crystals in the rocks surrounding the fossil sites. All the analyses were done at Stellenbosch University's Central Analytical Facility (CAF), which houses an LA-ICP-MS (ASI Resolution M-50-SE Excimer laser coupled to a Thermo Element 2 SF SC ICP-MS). An article on the research was published in *Communications Biology. – Dr Ryan Tucker*



Artistic reconstruction of *Moros intrepidus, by Jorge Gonzalez.*

ADVANCING PALEONTOLOGICAL RESEARCH AND SPECIMEN CONSERVATION IN SOUTHEAST ASIA

During the Cretaceous Period Earth's inhabitants endured climate changes that mirror our modern challenges, including a global temperature spike attributable to increased atmospheric CO_2 and dramatic sea-level rise that flooded coastal areas, dividing continents into island refugia. As a result of these changes, many species went extinct, redefining the composition of terrestrial ecosystems on a planetary scale. However, despite over a century of paleontological explorations in North America, little is known about how climate change affected plants and animals inhabiting Southeastern Asia during this time.

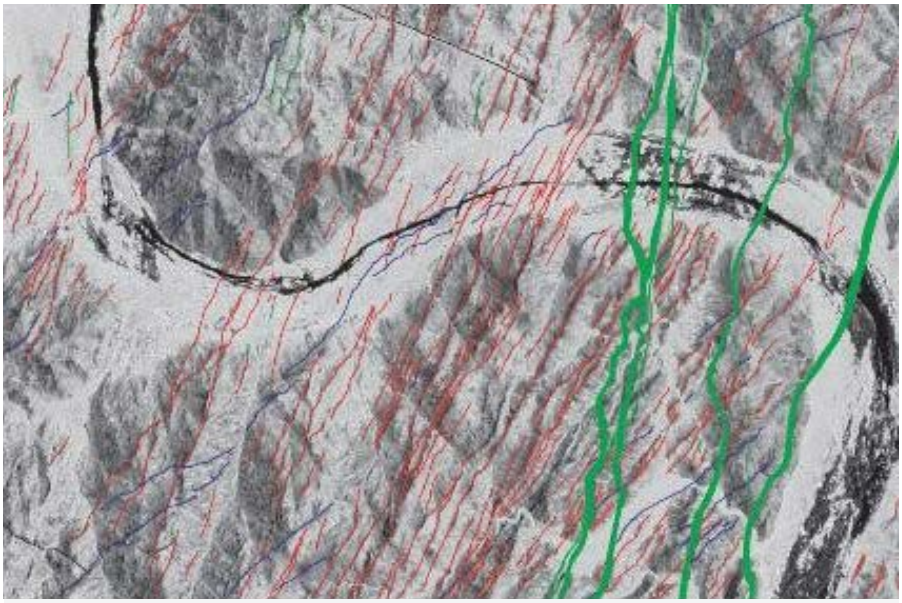
The Khorat Plateau, connecting Thailand, Laos, and Cambodia, contains one of the richest Cretaceous rock records in the region, offering the potential for scientists to make key discoveries that extend our knowledge of these effects across the Northern Hemisphere. However, reconstructing paleoclimate and biodiversity trends requires a multidisciplinary team of experts and mastery of the latest approaches for synthesizing palaeontological, sedimentological, stratigraphical, geochronological and geochemical data. Dr Ryan Tucker participated in a three-day symposium with private and public partners in the region, co-organised and led by three AC21 members, namely North Carolina State University in the USA, Stellenbosch University, and Kasertsart University and the Department of Mineral Resources in Thailand. The aim of the symposium was to provide an overview of the current state of knowledge

about south-eastern Asian geology and paleontology, as well as the challenges and opportunities for research and educational partnerships. This was followed by two weeks in the field, which saw the discovery of a new dinosaurian assemblage.

This international collaboration include the promotion of international graduate and undergraduate opportunities for students, intensive paleontological and geological study of Southeastern Asia, and professional development and training opportunities for regional partners in the collection of paleontological and geological data and long-term conservation of fossil resources. – *Dr Ryan Tucker*

DYKE SWARMS ACROSS SOUTHERN NAMIBIA

During June to July 2019, Dr Martin Klausen joined a geological mapping initiative by the Geological Survey of Namibia and South Africa's Council of Geoscience, in an attempt to resolve different dyke swarms across southern Namibia. Across the Richtersveld sub-province, these include the ~790 Ma Gannakouriep Suite, dykes likely related to Kuboos-Bremen (and other) complexes, and even the Palaeogene Klinghardt volcanic province. Across the Sinclair-Rehoboth inliers of the westernmost Kalahari craton, there is a pair of presumed ~1.1 Ga dyke swarms. While all dykes swarms are mapped in Google Earth some 260 samples form the basis of a first comprehensive geochemical study, with the possibility of even dating a few of these. The ultimate goal is to better constrain some of the many magmatic events that affected southern Namibia and relate these to tectonic settings and petrogenetic processes, as well as their magma differentiation and mechanisms of emplacement. – *Dr Martin Klausen*



Detail of the Sjambok section of the Orange River, where thicker Gannakouriep dykes (green) cut a denser suite of thinner bostonitic dykes (red). There are also some more oblique dykes in blue and black that remain to be classified.

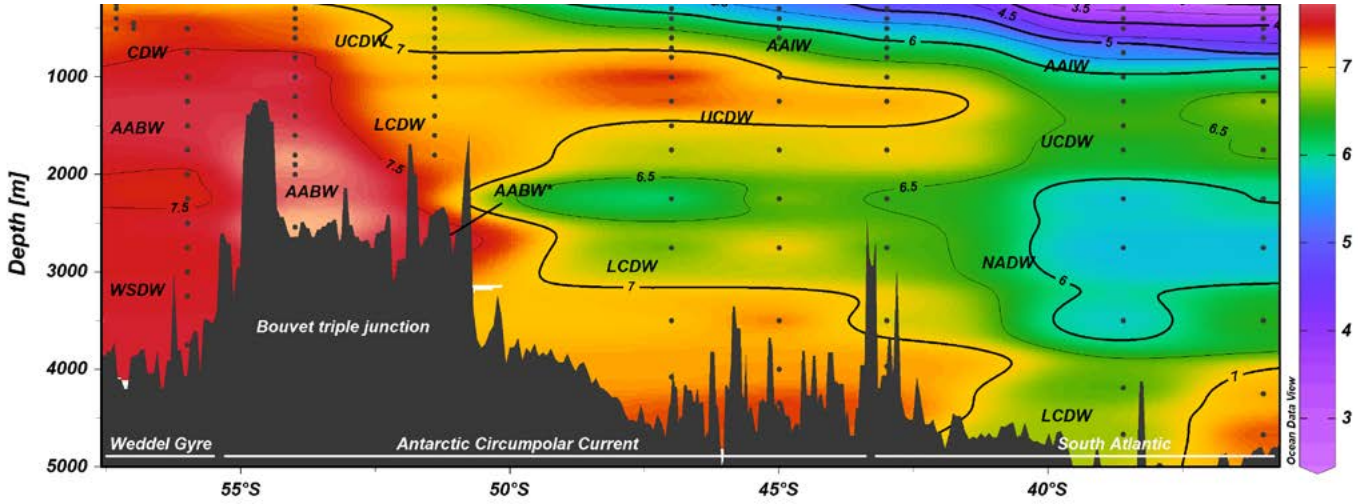
Image: Dr Martin Klausen

FIRST COMPREHENSIVE SEASONAL SAMPLING FOR TRACE METALS IN THE SOUTHERN OCEAN

The Trace Metal and Experimental Biogeochemistry (TraceEx) research group is interested in studying the distribution, sources, sinks, and cycling of trace elements and their isotopes in the Southern Ocean. This region is a key to the global carbon cycle. During 2019 the group participated in two expeditions to the Southern Ocean, including the marginal sea ice zone, in order to assess the seasonality of trace metal biogeochemical cycles. Trace metal data for Southern Ocean is sparse and winter data is all together lacking for most of the Southern Ocean leaving a large gap in our understanding of this critical region that modulates global climate through ocean productivity. A large focus of the group was on the marginal sea ice where trace metals are stored and are released during late spring and summer months. This is an increasingly important mechanism in a changing climate scenario for supply of micronutrients required for phytoplankton bloom that not only impacts the uptake of carbon dioxide from the atmosphere but also forms the base of the food chain for higher animals like whales.

Postgraduate students and researchers from SU spent nearly 10 weeks aboard the South African research vessel SA Agulhas II. This is the first time comprehensive seasonal sampling for trace metals at different interfaces was performed in the Atlantic sector of the Southern Ocean. The research team used state of the art clean sampling and analytical techniques developed at the TracEx lab to collect water column (> 800 seawater samples), sea ice (> 40 ice cores), snow (>140 snow samples) above the ice, and dry and wet aerosol samples (> 40 aerosol samples). The research will not only result in mapping the seasonal distribution patterns of various bioactive trace metals (see image on the next page) but their link to primary productivity through physical and chemical controls affecting major and trace element cycling in the Southern Ocean.

– *Prof Prof AN Roychoudhury*



Winter distribution of nickel between Africa and Antarctic marginal ice zone in the Southern Ocean. *Figure created by Bernhard Wenzel*

The TracEx group and their national and international collaborators that participated in the winter cruise to the Southern Ocean in 2019. *Photo:Wiida Fourie-Basson*

RECHARGE SYSTEMATICS IN THE TABLE MOUNTAIN GROUP AQUIFER

During 2019 the groundwater research group actively worked on using isotope tracers to track the interaction of precipitation, surface water and groundwater systems. This included the use of ^{3}H, ^{2}H, ^{18}O, ^{222}Rn, ^{14}C, $^{3}H/^{3}He$, ^{81}Kr and ^{39}Ar as indicators of water sources and residence times. We have been working along the west coast of South Africa between Cape Town and Springbok in the Northern Cape, although much of the work has been focused on the Western Cape as a result of the recent drought.

This work has been specifically looking at recharge systematics in the Table Mountain Group aquifer, where analysis of ^{222}Rn in the groundwater has clearly indicated sites of preferential recharge after large rain events. ^{222}Rn is present in low concentrations in precipitation but high concentrations in groundwater. When precipitation mixes with the groundwater it has the effect of diluting the groundwater ^{222}Rn activity concentration which we can measure. We have combined this work with residence time constraints using the novel isotopes of ^{81}Kr and ^{39}Ar but are still waiting on the results. This work is being done in conjunction with the Isotope Climatology and Environmental Research Centre (ICER) in Hungary as ^{81}Kr and ^{39}Ar are technically challenging isotopes to analyse. Associated with this work, we have been looking at groundwater quality and have been examining the role of "heuweltjies" (small saline palaeotermite mounds) in controlling groundwater salinity. Preliminary results suggest that termites brought windblown salts deposited on plant matter down into the heuweltjie structures. These salts were then washed down into the groundwater system over time. The relationship between heuweltjie distribution and saline groundwater distribution along the west coast of South Africa is still being explored. – *Prof Jodie Miller*

RESEARCH ACTIVITIES

Dr Susanne Fietz gave an invited lecture, "Proxies for the past", during the GEOTRACES Summer School, Cadiz, Spain, during September 2019. She made an oral presentation at the SA -Mexico Symposium on "Ocean biogeochemistry, pollution and remediation strategies" which took place in Mexico during June 2019; and another oral presentation during a mini symposium on Marine Microbial Ecology in Pretoria during January 2019. She was a plenary speaker at the 13th International Conference on Paleoceanography (ICP13) in Sydney, Australia in September 2019 on the development of paleo-climate proxies based on organic molecules (biomarkers). While in Australia she also gave an invited talk at the Geotraces Southern Ocean Biogeochemistry workshop in Hobart, Tasmania, 12 to 13 September 2019.

During 2019 Dr Fietz received and visited several international collaborators. Prof Dr Willy Bayens from the Vrije Universiteit Brussel visited the department in January 2019 to discuss a collaboration on Southern Ocean phytoplankton within the Horizon Europe Framework Program. Prof. Dr.-Ing. Jörg Schröder from the University Duisburg-Essen visited the department in January 2019 to discuss the proposal for an International Research Training Group (DFG-ITRG). Dr Fietz has a wide range of collaborators from South African and internationally. They are Dr Thulani Makhalanyane (Univeristy of Pretoria), Dr David Walker (CPUT), Drs Sarah Fawcett, Katye Altieri, Frank Eckardt (UCT), Drs Sandy Thomalla and Thomas Ryan-Keogh (CSIR), Rene Toetsie (Saldanha Bay Municipality). And on an international level she works with Prof Atle Bones (Norwegian University of Science and Technology), Dr Reza Zolfaghari (National Institute of Genetic Engineering and Biotechnology, Iran), Prof Christian Sohlenkamp (National Autonomous University of Mexico), Dr Mahjoor A. Lone (National Taiwan University), and Prof Joyanto Routh (Linköping University, Sweden).

Dr René Heyn supervised a master's research project in collaboration with the heavy minerals industry, Tronox Namakwa Sands (2018 – 2020). This orientation study comprised a U-Pb geochronology and geochemistry investigation on detrital zircon, rutile and ilmenite to establish a correlation between the U-Pb geochronology and geochemistry of coexisting zircon and rutile, which may significantly contribute to the understanding of provenance and geomorphological evolution of the Namakwa Sands heavy mineral deposit.

Dr Martin Klausen made an oral presentation at the Igneous and Metamorphic Studies Group (IMSG) meeting which took place within the Vredefort Impact Crater near Parys. He was a member of the local organising committee for two international conferences: the European Synchrotron Radiation Facility (ESRF) and South Africa joint workshop which took place in Johannesburg and Cape Town from 11 to 13 November 2019; and the Pan African Conference on Crystallography and the African Light Source (AfLS2) Joint Conference in Accra, Ghana, from 28 January to 2 February 2019.

Dr Matthew Mayne presented a poster at the ninth Hutton symposium on the origin of granites and related rocks in Nanjing, China, during October 2019, as well as at Petrochro-2019: Melting, modelling, dating the crust, Potsdam, Germany. He made an oral presentation at the Igneous and Metamorphic Studies Group (IMSG) meeting in Parys, South Africa.

Prof Jodie Miller was invited to deliver the keynote address at the 2019 International Atomic Energy Agency (IAEA) Isotope Hydrology Symposium, held in Vienna, Austria, and at the 29th Goldschmidt conference in Barcelona, Spain. During 2019 she was host to a large number of international visitors, including Dr László Palcsu, Dr Marjan Temovski, Dr Judit Orsovszki and Dr Anita Pukás-

Preszner from ICER, Hungary; Prof Mohamed Fethi Ben Hamouda from the Isotope Hydrology and Geochemistry Unit at the National Center for Nuclear Sciences and Technologies (CNSTN) in Tunisia; Prof Isaam Nouiri from the Tunisian Agronomic Institute (INAT); and Ms Evelyn Phakisa, Ms Malisema Fako and Ms Matsolo Migwi, all International Atomic Energy Association (IAEA) Fellows from Lesotho. Prof Miller also collaborated with researchers from the University of Lausanne (Switzerland), McGill University (Canada), the Centre for Process Mineralogy in the Department of Chemical Engineering at the University of Cape Town.

Prof AN Roychoudhury and several of his postgraduate students attended and presented papers and posters at several international conferences, including the fall meeting of the American Geophysical Union (AGU) in San Francisco, USA, from 9 to 13 December; and the Goldschmidt conference which took place in Barcelona, Spain, 18 to 23 August. During 2019 he was host to international visits by Prof B Mackey, Dr J-O Meynecke and Dr Serena B Lee from Griffith University, as well as Bernhard Wenzel, a visiting student participating in the European Masters' program in Ocean Sciences. During 2019 Prof Roychoudhury also collaborated with researchers from the Norwegian Polar Institute (Norway), Griffith University (Australia), University of Brest (France). Princeton University (USA) and Linköping University (Sweden). He also visited the Norwegian Polar Institute in Tromsø, Norway, for a data synthesis and project workshop, as well as an exploratory visit to the University of Mexico, Mexico City, to investigate bilateral research project collaboration.

Prof Gary Stevens visited the Aigoual Pluto and associated dykes in France in order to establish a new research program in crustal evolution of the Massif Central in collaboration with Prof Jeff Moyen of the University of Sain Etienne. Other collaborators are Prof Cris Lana, University of Ouro Preto; Prof Dirk Frei, University of the Western Cape; Prof Chris Harris, University of Cape Town, and Prof Daniel Vielzeuf, Centre national de la recherché scientifique (CNRS), Marseille.

The complexity of textural relationships between different components of the Aigoual Pluton. *Photo: Gary Stevens*

Dr Bjorn von der Heyden was involved in organising and attending the Pan African Conference on Crystallography and the African Light Source (AfLS2) Joint Conference, which took place in Accra, Ghana, from 28 January to 2 February 2019, as well as a joint workshop between the European Synchrotron Radiation Facility (ESRF) and South African researchers in Johannesburg and Cape Town from 11 to 13 November 2019. Dr Von der Heyden presented a Science Café Stellenbosch talk on the advantages and disadvantages of hosting such a facility on the African continent. A detailed review of how synchrotron light can advance the field of ore geology research, was published in the journal *Ore Geology Reviews*.

Dr Von der Heyden presented two papers at the 15th Biennial SGA (Society for Geology Applied to Mineral Deposits) meeting in Glasgow, Scotland, from 27-30 August 2019. He attended the 11th Igneous and Metamorphic Study Group Meeting, Vredefort, from 13-16 January 2019, as well as the DST-NRF CIMERA annual colloquium in Johannesburg on 8 November 2019). He visited Midlands State University's (MSU) Department of Mining Sciences and Engineering. This visit was aimed at promoting South-South collaborations and was funded by a Royal Society of Engineering grant awarded to MSU as the main recipient and SU and University of Cardiff as supporting institutions. The visit has resulted in MSU formally being recognised as a research collaborator through SU's International Research office.

SERVICE TO THE SCIENTIFIC COMMUNITY

Dr Susanne Fietz serves on the GEOTRACES Steering Committee and is editor for *International Review of Hydrobiology.*

Dr Martin Klausen serves on the Geological Survey of Namibia and the Council of Geoscience.

Prof Alex Kisters is an external reviewer for the Departments of Geology at the University of Namibia and the University of Orange Free State. He is chairman of the South African Committee for Stratigraphy, Neoproterozoic sequences, and a committee member of the Archaean working group of the South African Committee for Stratigraphy.

Dr Matthew Mayne is a reviewer for Geoscience Frontiers. He participated in the YEBO! project workshop on "Developing a Toolbox for Managing International Collaborative PhD programmes" in Cape Town, June 2019; he presented at an orientation workshop for new PhD students at SU, and acted as a judge for the Eskom Science Expo's regional competition in Stellenbosch.
Prof AN Rouchoudhury is a member of the editorial board of *Results in Geochemistry;* Associate Editor of *Frontiers in Environmental Sciences: Groundwater Resources and Management* and Review Editor for *Frontiers in Marine Science: Ocean Observation.*

Prof Jodie Miller is vice chair of the International Association of Geochemistry and co-champion of the DST SARIR Biogeochemistry Platform (BIOGRIP).

ACADEMIC AFFAIRS

For the second year in a row Dr Susanne Fietz was involved with the first year Science in Context projects. In 2018, five groups worked on the topic of "Heavy metal and hydrocarbon (oil) pollution along southern African coasts: how bad is it and how can microbes help remediation?" This work is part of an ongoing SA-Mexico bilateral project. The topic of the 2019 project was "Potential sources, pathways and impacts of contamination in Saldanha Bay, South Africa". It originated from the joint interest Dr Fietz and PhD candidate Ismael Kangueehi have with Saldanha Bay Municipality on air quality and impact of dust at Saldanha Bay.

During 2019 the French Centre National de la Recherche Scientifique (CNRS) formally recognised Prof Gary Stevens' collaborative research project "Dynamics, differentiation and resources of the Archaean Lithosphere". The project, which is centred between Stellenbosch University and the University of Saint Etienne, involving collaborators at a number of other French and South African universities, has produced three joint degree PhD students in recent years, Matthew Mayne, Adrien Vezinet and Gautier Nicoli. Tahnee Otto and Moritz Muhlberg are currently joint degree PhD students involved in the project.

NRF-RATED RESEARCHERS		
Internationally acclaimed researchers	Prof JD Clemens (retired)	Granite petrogenesis
	Prof A Kisters	Structural geology
	Prof G Steven	Experimental petrology
	Prof A Roychoudhury	Environmental geochemistry and hydrology
Established researchers	Prof Jodie Miller	Isotope geology, geohydrology
	Dr S Fietz	Environmental geochemistry, biogeochemistry
Y-2	Dr B von der Heyden	Earth sciences

FUNDING

South Africa
Anglo-American
Black Mountain Mining
DSI-NRF CIMERA (Centre of Excellence for Integrated Mineral and Energy Resource Analysis)
iPhakade Program, South Africa
National Research Foundation (NRF)
National Research Foundation (NRF) – African Origins Platform (AOP)
National Research Foundation South Africa/France PROTEA Programme
National Research Foundation of South Africa/Norway SANOCEAN Programme
Tronox Namakwa Sands
Water Research Commission (WRC)
International
AC21 (Advancing paleontological research and specimen conservation in Southeast Asia)
International Atomic Energy Agency (IAEA), United Nations
National Science Foundation (NSF) Frontier Research in Earth Sciences (FRES), USA

AWARDS TO STAFF AND STUDENTS

MSc-student Jonathan Gloyn-Jones received the Geological Society of South Africa's (GSSA) award for the best MSc thesis in Earth Sciences in South Africa, and BScHons student Lindo Makhathini received the GSSA's SACNASP (South African Council for Natural Scientific Professions) award for the best 2018 Honours' thesis in Earth Sciences in southern Africa. Her work looked as the reasons for the anomalously black colouration in auriferous quartz veins collected from the Fairview mine in Barberton.

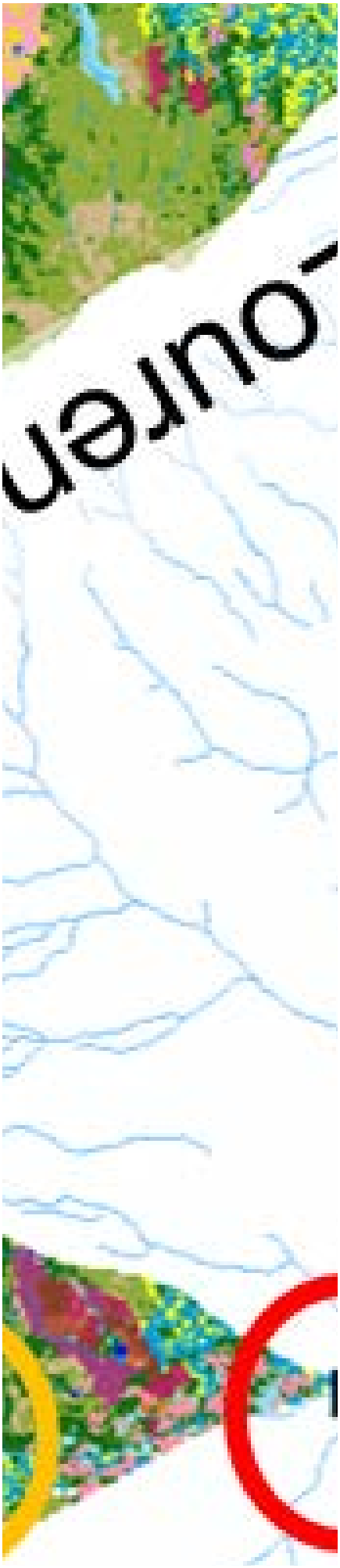
Several postgraduate students attended the 11th Igneous and Metamorphic Studies Group Meeting at Kopjeskraal Guest Farm in Parys, from 13th to 16 January 2019, hosted by the University of the Witwatersrand. SU was well represented with student talks by Nonkuselo Madlakana, Moritz Muhlberg, Tanisha Schultz and Matthew Mayne, as well as lecturers Dr Martin Klausen, Dr Bjorn von der Heyden and Prof John Clemens. Mr Mayne won the prize for the best PhD presentation.

STAFF MATTERS

2019 was a year of changes and we bode farewell to two long-serving staff members. Prof John Clemens retired at the end of 2018 after 11 years of service to the department. Prof Clemens was the Executive Head of the Department between 2008 and 2012 and taught second-year mineralogy and Honours igneous petrology. Throughout this time he managed to maintain a most prominent and productive research profile working on anything granite related.

Prof Ian Buick took early retirement in the first part of 2019 after nearly ten years in the department, where he was responsible for the third year and Honours teaching of metamorphic petrology. Dr Matthew Mayne follows in Prof Buick's footsteps as the newly appointed lecturer in metamorphic petrology. He joined the department in June 2019. Dr Mayne's research interests lie in the field of phase equilibria modelling where he actively develops and fine-tunes software packages to quantitatively model processes of crustal differentiation.

We are happy to report on the promotions of Dr Jodie Miller to Associate Professor at the beginning of 2019 and promotion of Dr Bjorn von der Heyden to Senior Lecturer at the end of 2019.



STAFF LIST

Academic

Dr S Fietz
Dr R Heyn
Prof A Kisters
Dr M Klausen
Dr M Mayne
Dr J Miller
Prof A Roychoudhury
Prof G Stevens
Dr R Tucker
Dr B von der Heyden

Extraordinary professors

Dr I Basson, Tect Consultancy
Dr L Bracciali (senior lecturer), CAF, SU
Dr G Brown, Boswell Capital, Toronto Canada
Dr D Cornell, formerly Gothenburg University, Sweden
Dr M De Wit, consultant
Dr N Phillips, Phillipsgold, Australia

Support staff

Ms M Frei
Mr G Olivier
Ms G Strydom
Mr F Timney

Emeritus professor

Prof JD Clemens
Prof A Rozendaal

Postdoctoral fellows

Dr A Baker
Dr G De Oliveira Goncalves
Dr JL Menzel
Dr M Storm
Dr S Saumik
Dr A Watson

SOCIAL IMPACT

Dr Bjorn von der Heyden gave a talk entitled "Carbon compounds and allotropes: Importance of coal as an energy source locally and internationally" presented with Dr John Bristow to the Overberg U3A Society in Hermanus on 12 February 2019 in celebration of The Geological Society's Year of Carbon. He also presented a Science Café Stellenbosch talk, entitled "Illuminating Africa with synchrotron light" on 7 August 2019.

Dr Matthew Mayne and Robyn Symons reached the semi-finals of the SAASTA FameLab competition.
Dr Susanne Fietz manages several social media platforms, namely the TracEx Team Blog (https://southernoceanfe.wordpress.com), the TracEx Team Facebook page (https://www.facebook.com/Environmental-Geochemistry-at-Stellenbosch-University-135430226505633/) and the TracEx Team Twitter handle, @TracexS.

Organised by SU's Centre for Student Recruitment and Career Advice, the department hosted 120 Grade 6 learners from Sun Valley Primary and Fish Hoek Primary in August; and in October we hosted 25 Grade 10 learners from Delft Technical High School. The learners were exposed to topics in climate change and ocean chemistry.

The Tracex team sent special greetings for the Delft Tech learners all the way from the Antarctic ice.

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DEPARTMENT OF MATHEMATICAL SCIENCES

RESEARCH INTERESTS

Applied Mathematics Division

Computer vision, pattern recognition, machine learning
Fluid dynamics and modelling
Numerical analysis and scientific computing
Applied discrete mathematics

Computer Science Division

Artificial Intelligence, Machine Learning and Data Science
Automata and Grammars: Theory and Applications
IP networks
Software Engineering and Verification

Mathematics Division

Algebra
Algebraic number theory and arithmetic algebraic geometry
Discrete mathematics and algorithms
Foundations of mathematics
Topology
Functional analysis
Biomathematics and computational biology

RESEARCH HIGHLIGHTS

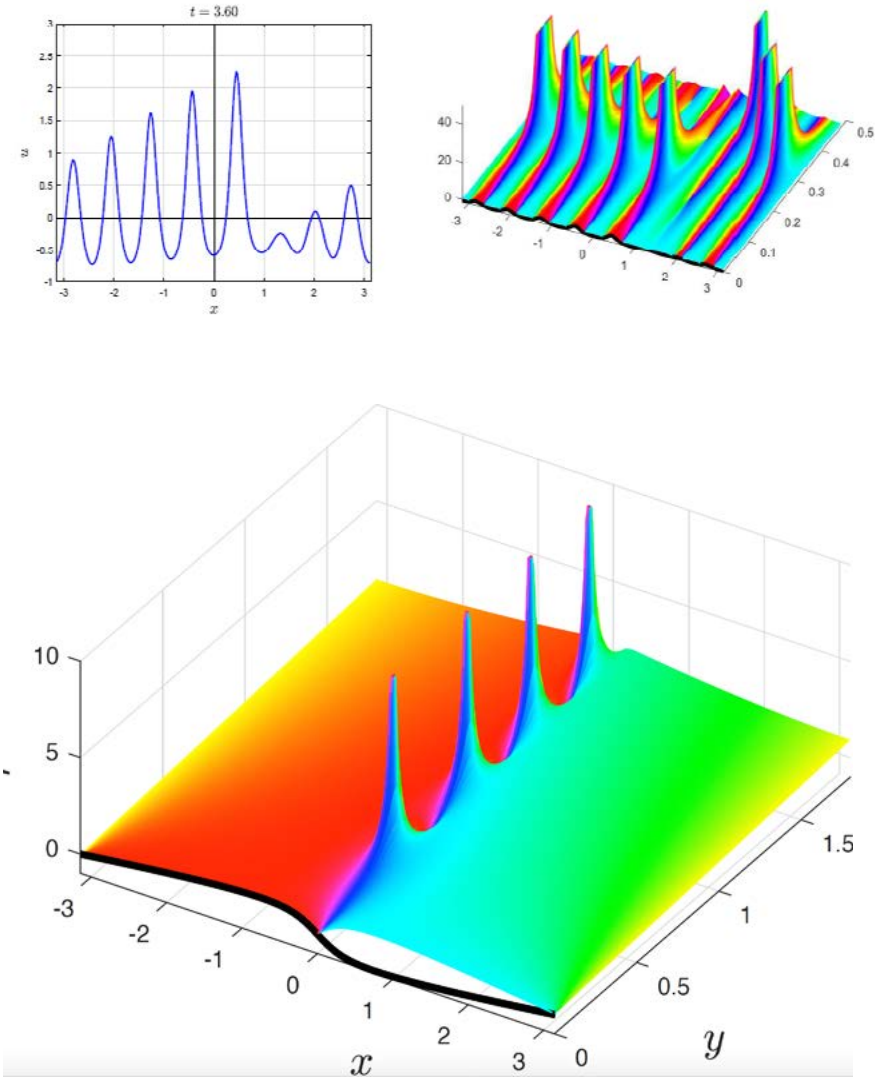
First African women in mathematics conference at SU

From 2 to 5 July 2019 nearly 60 women mathematicians from Africa, including Nigeria, Benin, Madagascar, Kenya, Ghana and Morocco and South Africa gathered at Stellenbosch University (SU) for the African Women in Mathematics (AWiM) conference. This was the first of what will be an annual conference, contributing to the rising tide of efforts worldwide to support and encourage women in mathematics and to attract women and female learners to mathematics (pure and applied). The overarching aims of AWiM are the showcasing and upliftment of women in mathematics in Africa and providing a platform for research collaboration, for networking, for reflecting on experiences, for working towards addressing key challenges of women in mathematics in Africa, and for engaging with female learners and teachers in the surrounding area thereby increasing the likelihood that they may consider mathematical sciences for further study.

On 12 May, staff and students in Mathematical Sciences also joined mathematicians from around the world to celebrate Women in Mathematics on 12 May. This day is significant in that it is the birthday of Maryam Mirzakhani – the first woman to be awarded in 2014 the Fields medal for "her outstanding contributions to the dynamics and geometry of Riemann surfaces and their moduli spaces". Sadly three years later, at the age of 40, she died of breast cancer. The celebratory event in the department, organised by Dr Karin-Therese Howell, was one of more than 100 events worldwide.

Project computation of pole dynamics in nonlinear Partial Differential Equations

In 1965 Norman Zabusky and Martin Kruskal conducted a famous computer experiment, in which they simulated water waves as described by the Korteweg-de Vries equation. They discovered that certain solitary waves have the property that they pass through each other without a change in shape, something quite unexpected for nonlinear interaction. These waves became known as solitons, and the discovery provided an explanation of the particularly stable 'waves of translation' that were observed in canals going back to the mid-1800s. Kruskal conjectured that the complicated nonlinear interaction could be explained by extending the solution into the complex plane, but this is not an easy exercise because of the intractability of the equations. The alternative is to model also the complex plane behaviour by computer methods, but this too is challenging because of inherent instabilities in the system. When Prof André Weideman was invited to present a talk at the 2019 ICIAM meeting in Valencia, Spain, he took up the challenge and computed what is believed to be the first 'complex plane representation' of the Zabusky-Kruskal experiment. The figure below is a reproduction of the iconic picture from the 1965 paper that shows eight solutions. The phase plot on the right is believed to be the first continuation of that solution into the complex plane. The peaks represent complex poles (where the solution is unbounded) and each one of them corresponds to a soliton on the left - *Prof André Weideman.*



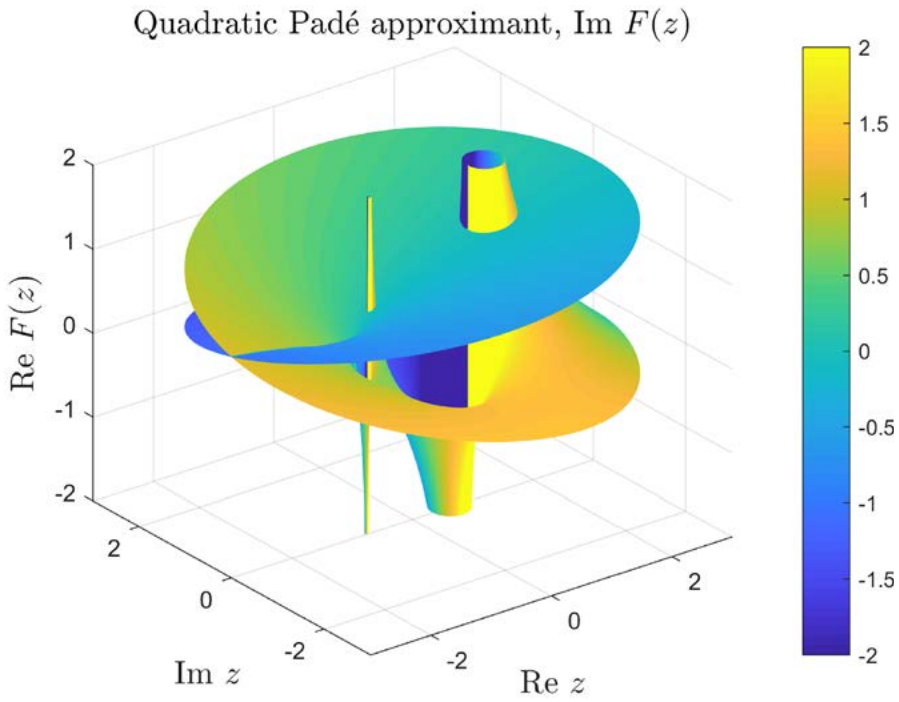
Pole dynamics of the viscous Burgers equation

RESEARCH FOR IMPACT

Dr Gareth Boxall's paper "Rational values of transcendental functions and arithmetic dynamics" together with Gareth Jones and Harry Schmidt, was accepted to appear in the highly regarded *Journal of the European Mathematical Society.*

Dr James Gray's paper "Hall's criterion for nilpotence in semi-abelian categories" was published in the prestigious *Advances in Mathematics.*

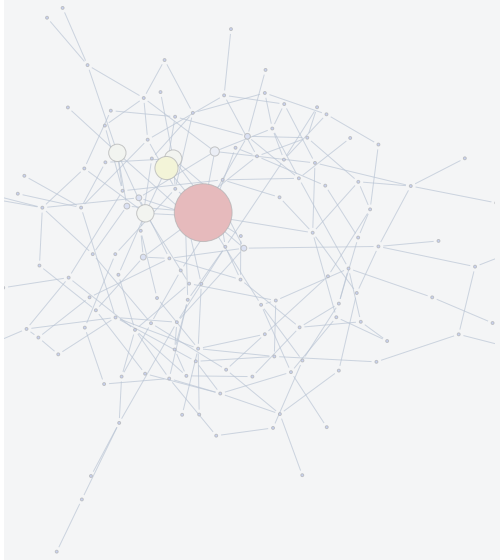
Prof Nick Hale's paper "Quadratic Padé approximation", with M. Fasondini, R. Spoerer, and J.A.C. Weideman, appeared in *Computer Research and Modeling*.



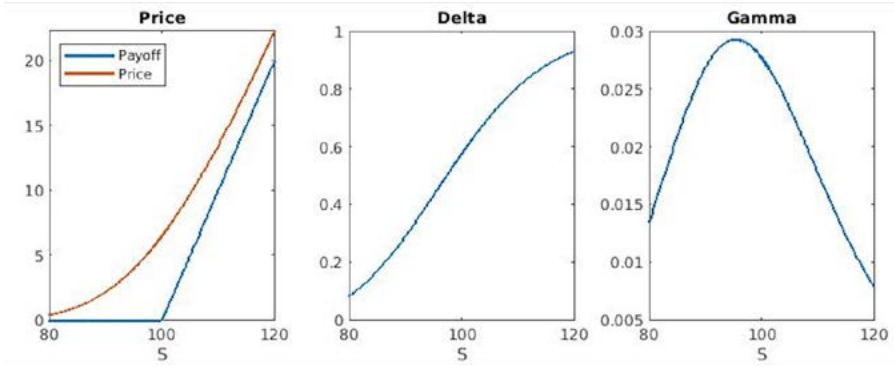
Representation of the two-sheeted Riemann surface of the (5,5,5) approximation to the function $f(z) = (1+z)^{1/3}$

$s = -2.0$

$s = 2.0$



Prof Nick Hale's research paper 'Pricing European-type, Early-Exercise and Discrete Barrier Options using an Algorithm for the Convolution of Legendre Series', with T.L. Chan, to appear in *Quantitative Finance*.



Price and greeks of a GBM european option computed using the CONLeg method.

Discussing below-ground invasive legume-rhizobium symbiotic promiscuity with colleagues at the molecular ecology laboratory of the DSI-NRF Centre of Excellence for Invasion Biology (CIB). From left to right, Prof Allen Ellis (Department of Botany and Zoology), Prof Johannes Le Roux (Macquarie University), Dr Jan-Hendrik Keet (CIB), and Prof Cang Hui.

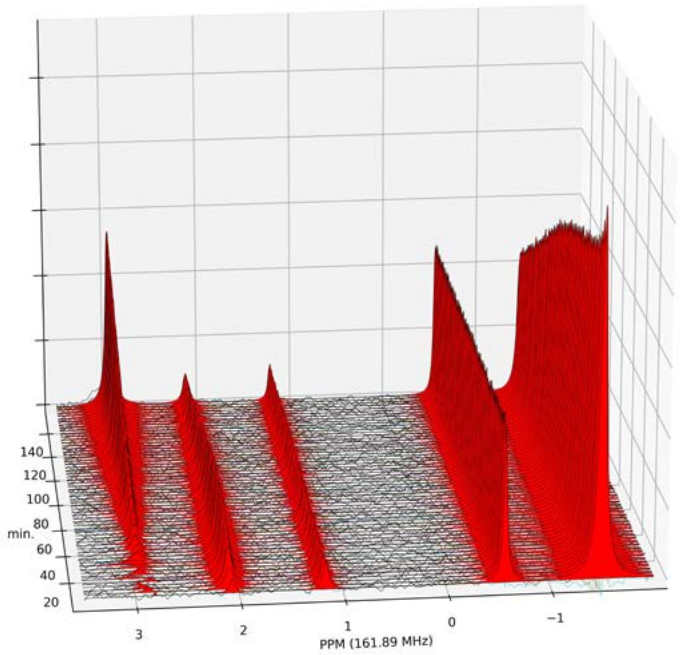
Prof Cang Hui's research is undoubtedly advancing the knowledge frontiers in Mathematical and Physical Biosciences. His work is widely cited, with over 5750 citations and the number of citations increasing steadily by about 100 citations each year since 2016. His h-index is an impressive 40. It is noteworthy that a 2019 paper on climate already has 28 citations. In this way he is contributing to the university's core strategic theme of Research for Impact as well as one of the top 15 global challenges, namely sustainable development and climate change. In particular, four of his publications received attention in the media: He was part of an international team of more than 200 scientists who have generated a global map, involving more than 31 million trees and 28 000 tree species, which reveals the symbiotic relationship between trees and microbes worldwide. Published in *Nature*, led by Stanford scientist Brian Steidinger, this work could help scientists and policy makers understand how symbiotic partnerships structure the world's forests and how they could be affected by climate change. The article, "Climatic controls of decomposition drive the global biogeography of forest-tree symbioses" was published in the journal Nature 569 (7756) in May 2019.

Nature tree dimensions cover page

Prof Hui is also part of a research team that has confirmed the extinction of 79 plants in South Africa's three biodiversity hotspots – namely the Cape Floristic Region, the Succulent Karoo, and the Maputuland-Pondoland-Albany corridor. According to the article "Recent anthropogenic plant extinctions differ in biodiversity hotspots and coldspots" published in the journal this represents a shocking 45.4% of all known plant extinctions from 10 of the world's 36 biodiversity hotspots. Biodiversity hotspots are areas that harbour exceptionally high numbers of unique species, but at the same time they are under severe threat from human disturbance. Together with Prod DM Richardson, he wrote an opinion piece, titled "How to Invade an Ecological Network", which appeared in *Trends in Ecology and Evolution.*

Prof Zurab Janelidze, co-authored with A. Goswami, the paper "Duality in non-abelian algebra IV. Duality for groups and a universal isomorphism theorem" which appeared in the prestigious journal. This paper answers a fundamental research question from the paper "S. Mac Lane, Duality for groups historical to the field of categorical algebra. The first three papers in the series, "Duality in non-abelian algebra I-III", which led to the current fourth edition, were published in 2014-2016 by Z. Janelidze and a former MSc student of his, Thomas Weighill.

Dr Guillaume Latombe, a postdoctoral fellow in the Prof Cang Hui's research team, was the lead author on the paper "A four-component classification of uncertainties in biological invasions: implications for management", published in the journal *Ecosphere*.



The four-component framework (circumscription of the phenomenon, confirmation of the existence of the phenomenon, mechanistic causes of the phenomenon and mechanistic consequences) upon which sustainable management actions must be built.

Prof Leon Van Wyk published four research papers during 2019 of which the paper, "The maximum dimension of a Lie nilpotent subalgebra of $M_n(F)$ of index m" published in the prestigious *Transactions of the American Mathematical Society* was the highlight.

RESEARCH ACTIVITIES

Dr Bruce Bartlett attended the conference, New Developments in Quantum Topology, which took place from 3-7 June 2019 at the University of California Berkeley. His current PhD student, Hosana Ranaivomanana and his former PhD student (now faculty at NWU) Gerrit Goosen also attended the conference. Dr Bartlett also presented a teaching and learning innovation called "Online Interactive Textbook for W214" at the Stellenbosch University Scholarship of Teaching and Learning Conference, October 2019.

Dr Dirk Basson hosted Dr Magdaleen Marais from the University of Pretoria and Dr Janko Böhm from the University of Kaiserslautern in Germany for a research visit to investigate a new algorithm to compute the normalisation of a singular ring.

Dr Ronalda Benjamin presented her research at five conferences: "The connected hull of the upper Weyl spectrum" at the African Women in Mathematics Conference, Stellenbosch, South Africa, 2 - 5 July 2019; "A spectral mapping theorem for the upper Weyl spectrum" at Positivity X, Pretoria, South Africa, 8 -12 July 2019; "Connections between Fredholm theory and positivity in general ordered Banach algebras" at the Banach Algebras and Applications conference in Canada, 11-18 July; "The Lozanovsky spectrum of a positive element" at the NWU Mathematics Workshop 2019, in Potchefstroom, 25 -27 September; "r-Fredholm theory in ordered Banach algebras" at the annual congress of the South African Mathematical Society in Cape Town , 2-4 December. She was also a guest speaker at the AIMS Mathematical Sciences Student Academic Conference in Muizenberg where she gave a talk on "The upper Weyl spectrum of an arbitrary ordered Banach algebra".

Dr Gareth Boxall gave a talk entitled "Remarks on a question of Levin" at the AIMS-Stellenbosch Number Theory Conference in January 2019. In that month he was also visited by Dr Gareth Jones of the University of Manchester and Dr Harry Schmidt, University of Basel. He visited Dr Jones at the University of Manchester and gave a talk there entitled "A special case of quasiminimality". In September 2019 he was visited by Dr Sylvy Anscombe of the University of Central Lancashire who gave a colloquium talk here entitled "A p-adic analogue of Siegel's theorem on sums of squares". She also contributed some lectures to the Honours model theory module. In October/November 2019 he visited Dr Charlotte Kestner at Imperial College London and gave a Logic Seminar talk there entitled "Distal Shelah expansions".

Dr Willie Brink attended the Machine Learning Summer School in Stellenbosch during January 2019. He was an invited speaker at the Deep Learning Indaba X South Africa, Durban, in April 2019 and presented a paper at the 57th Annual Meeting of the Association for Computational Linguistics (ACL), Florence, Italy in July 2019. He co-organised the third Deep Learning Indaba held in Nairobi, Kenya in August 2019.

Dr Maret Cloete presented a paper at the South African Ballistics Organisation Conference, Macassar, South Africa in September 2019.

Dr Andie De Villiers gave a poster presentation at CMCS 2019 (Computational Modelling of Complex Materials across the Scales), Glasgow, UK in October 2019. She serves on the executive committee of the South African Association for Theoretical and Applied Mechanics (SAAM).

Dr Hardus Diedericks presented a paper at the 19th International Conference on Transport and Sedimentation of Solid Particles, Cape Town in September 2019.

Prof Andries Engelbrecht presented a keynote address "A Hyper-Heuristic Framework for Dynamic Optimisation Problems" at the SA Forum for Artificial Intelligence Research Conference, Cape Town. He presented a tutorial "Recent Advances in Particle Swarm Optimisation Analysis and Understanding" at Genetic and Evolutionary Computation Conference, Prague, Czech Republic. He attended the IEEE Congress on Evolutionary Computation, Genetic and Evolutionary Computation Conference, International Conference on Swarm intelligence, Auckland New Zealand. He has sustained research collaboration with Brock University, Griffith University, Indian Institute of Technology Roorkee, Rey Juan Carlos University, Institute of Agriculture and Food Research and Technology (IRTA) Spain, Cambridge University, University of Ontario Institute of Technology. He served as the vice-chair of the Evolutionary Computation Technical Committee of the IEEE Computational Intelligence Society and as an external examiner for a PhD thesis from Swinburne University.

Dr Sonia Fidder presented a paper at the 10th International Conference on Computational and Experimental Methods in Multiphase and Complex Flow, Lisbon, Portugal in May 2019. She has strengthened her collaboration with the researchers in the Department of Energy and Environmental Systems at IMT Atlantique in Nantes, France on predicting the permeability of fibrous porous media subject to compression for the application of air filtration and predicting the effect of biofilm growth on the pressure drop over a biofilter. She served on the organizing and scientific committee of the 19th International Conference on Transport & Sedimentation of Solid Particles held in Cape Town in September 2019. She is the Vice-President of the Southern African Society of Rheology.

Prof Bernd Fischer is a member of the IFIP TC-2 Working Group 2.11. He attended and presented his research at three international conferences: "SMT-based refutation of spurious bug reports in the clang static analyzer" at the 41st International Conference on Software Engineering (ICSE 2019); "Breaking Parsers: Mutation-based Generation of Programs with Guaranteed Syntax Errors" at the 12th International Conference on Software Language Engineering (SLE 2019); "VeriSmart 2.0: Swarm-Based Bug-Finding for Multi-threaded Programs with Lazy-CSeq" at the 34th IEEE/ACM International Conference on Automated Software Engineering (ASE 2019). He visited University eSwatini as part of the UK Royal Academy of Engineering Higher Education Partnerships in sub-Saharan Africa (HEP SSA) grant "A framework for creating, transferring, commercialising and exchanging knowledge within and between sub-Saharan universities and industries" with with University of Essex (GB), Canterbury Christ Church University (GB), Glasgow Caledonian University (GB), University of eSwatini (Swaziland), National University of Lesotho and the National University of Science and Technology (Zimbabwe). He also visited Prof Grünbacher, JKU Linz, Austria (as Research Fellow), Prof Grunske, HU Berlin, Germany, and Prof Schaefer, TU Braunschweig, Germany. He was visited by Prof Schaefer, TU Braunschweig, Germany. He secured the South Africa - Sweden University Forum (SASUF) collaboration grant "Network Testing and Fuzzing for a Reliable and Secure Internet of Things", with Uppsala University (Sweden), KTH Stockholm (Sweden), Central University of Technology (Bloemfontein) and Walter Sisulu University (East London).

Dr James Gray gave a talk entitled "On the representability of actions of the category of internal categories of a semi-abelian category", at the 105th Peripatetic Seminar on Sheaves and Logic, Palermo, Italy. He visited Tim Van der Linden and Marino Gran at the Université Catholique de Louvain in Belgium.

Prof Nick Hale presented his research at SANUM (South African Numerical and Applied Mathematics), Pretoria in March 2019 and at the Complex Analysis Workshop held at the Newton Institute, University of Cambridge, UK in December 2019. He was a member of the committee that successfully bid for the fifth BRICS Mathematics and Statistics Conference to be held at Stellenbosch University in November 2021.

Dr Michael Hoefnagel began collaboration with D. Rodelo and Z. Janelidze resulting in a paper recently accepted in *Algebra Universalis*. He continued collaboration with P.A. Jacqmin at the University of Louvain-la-Neuve in Belgium. He presented his research 'M-coextensive objects and the strict refinement property' as a plenary talk at the international conference in Category Theory (CT2019) and as a research talk at the annual congress of the South African Mathematics Society in Cape Town , 2-4 December.

Dr Karin-Therese Howell continued her collaboration with Prof Philippe Cara (Vrije Universiteit, Belgium) and Prof Nancy Neudauer (Pacific State University, USA). She is also a member of the AIMS Executive Council and was elected Secretary of the South African Mathematical Society Council.

Prof Zurab Janelidze gave invited talks at the 13th Annual Western Cape Advanced Programme Mathematics Workshop 2019, held in May in Franschhoek, at the 25th Annual Congress of Association of Mathematics Education of South Africa 2019, held in July in Kwa-Zulu Natal, and at the International Logic Workshop 2019 held at the University of Johannesburg in January. Prof D. Rodelo from the University of Algarve visited Dr Michael Hoefnagel and Prof Zurab Janelidze in the Categorical Research Group in November 2019, to collaborate on the topic of "Difunctionality of class relations" in universal algebra.

Dr Steve Kroon attended Data, Learning and Inference (DALI) (by invitation) held in George, the Machine Learning Summer School hosted in Stellenbosch, and the Workshop on Advances in Knowledge Engineering, Reasoning, and Sensemaking (WAKERS) (by invitation) in Stellenbosch. His PhD student Jordan Masakuna, co-supervised with Simukai Utete at the African Institute for Mathematical Sciences, presented his work on effectively coordinating autonomous robots at the third IEEE International Conference on Robotic Computing (IEEE IRC) in Naples in February.

Dr Sophie Marques presented her research at three conferences: the African Women in Mathematics Conference, Stellenbosch University, July 2019; the Topology and Algebra Conference, UCT; Conference Day in honor of Alberto Facchini, Stellenbosch University. She also presented her work at the Workshop on Categorical Algebra, Stellenbosch University. She received two international research visitors: Dr Alberto Facchini (University of Padova, Italy) and Dr Dajano Tossici (University of Bordeaux) and continued her research collaboration with Ben Blum Smith, Frederick Greenleaf, Jacob Ward (deceased), Valentijn Karamaker, Jeroen Sijsling, Karin Howell, Lee Boonzaaier.

Dr Sonja Mouton presented a plenary talk titled 'Fredholm theory and r-Fredholm theory in ordered Banach after algebras with Positivity X, Pretoria, South Africa, 8 -12 July 2019. She also presented the paper 'Linking the boundary and exponential spectra via the restricted topology' at Banach Algebras and Applications, an international conference held in Winnipeg, Canada, 11-18 July and the paper 'r-Fredholm theory in Banach algebras' at the annual congress of the South African Mathematical Society in Cape Town, 2-4 December .

Mr S'yande Mungwe presented his doctoral research at SANUM (South African Numerical and Applied Mathematics), Pretoria in March 2019. Mr Mkhuseli Ngxande completed his PhD in the field of machine learning at UKZN and as part of the CSIR Image Processing Group.

Prof Helmut Prodinger visited for the Technical University of Graz where he is an honorary Professor. He welcomed research guests on 27 February on the occasion of his 65th birthday.

Dr Naina Ralaivasosaona presented a talk "Sparse random acyclic digraphs" at the Annual Congress of the South African Mathematical Society (SAMS) December 2019. He visited École Normale Supérieure, University of Antananarivo Madagascar, June--July 2019, to work on sparse random acyclic digraph project with Dr Vonjy Rasendrahasina. He also visited Academia Sinica, Taiwan, 8--25 Nov 2019, to work on number of summands in integer partitions with Prof Hsien-Kuei Hwang. He serves as the CoE-MaSS Junior Focus Area Coordinator for Number Theory.

Prof Ingrid Rewitzky presented a research paper on "A conceptual framework for understanding the complexities of Mathematics proficiency" at the third International Legitimation Code Theory Conference, Johannesburg, July 2019; a plenary talk on "Insights from orthogonality for mathematics" at the African Women in Mathematics Conference, Stellenbosch, South Africa, 2-5 July 2019; a Stellenbosch University Auxin Seminar on "Insights from orthogonality for mathematics" in August 2019; and a research talk on "A conceptual framework for excellence with purpose in Mathematics" at the SU Scholarship of Teaching and Learning Conference, October 2019. She was invited to contribute two book chapters, namely "A conceptual framework for excellence with purpose in Mathematics" for the *Series on Legitimation Code Theory: Knowledge-building in Research and Practice* and "A Care-full approach to professional development in a science context" with H. Addendorff and I. Rootman-le Grange in *Reconceptualizing academic development: A South African perspective.*

Dr Riana Roux was on research leave for the second semester of 2019. During this time she participated in the seventh Gdansk Workshop on Graph Theory, Gdansk, Poland in July 2019 and the Combinatorial Potlatch, Bellingham, USA in November 2019. She had a research visit to and from Prof CM Mynhardt, University of Victoria, Canada as well as a research visit to Drs Dettlaff and Lemanska, Gdansk University of Technology, Poland.

Prof Francois Smit presented a paper at the South African Ballistics Organisation Conference, Macassar, South Africa in September 2019.

Prof Hugo Touchette was a keynote speaker for the David Chandler Memorial Lecture, Berkeley Statistical Mechanics Meeting, University of Berkeley, USA in January 2019 and at the 15th Joint European Thermodynamics Conference, Barcelona, Spain in May 2019. He was an invited speaker for Rare Events, Information Theory and Statistical Physics: A Conference Celebrating Richard S. Ellis, UMass Amherst, USA in April 2019 and have an invited lecturer at the Summer School on Rare Events: Applications, Computation, and Theory, IISc Bangalore, India in July 2019. In addition, he received three international research after visitors

Dr Raphael Chetrite, University of Nice, France, January 2019; Prof Arnaud Guyader, University of Paris, France, February 2019; Dr Gregoire Ferre, University of Paris-Sud, France, December.

Prof Brink van der Merwe secured the South African and Swedish University Forum collaboration grant with Johanna Björklund and Partik Ryden from Umeå University for a project titled "Prehospital Resource Optimisation".

Prof Leon van Wyk visited his research collaborator Prof Michal Ziembowski at the Warsaw University of Technology, Warsaw, Poland, 1-13 September.

Prof Lynette van Zijl was on research leave in 2019. She hosted international visitor Prof Jacqueline Daykin, from Aberystwyth University in Wales, as part of a joint research project between Aberystwyth University, University of Cape Town and Stellenbosch University, funded by Global Challenges Network.

Prof André Weideman was on research leave in 2019. During this time he was an invited speaker at the International Congress on Industrial and Applied Mathematics, Valencia, Spain in July 2019 and at the 3rd BRICS Conference on Mathematics and Statistics, Innopolis, Russia in July 2019. He was also the organizer of the research program on Complex Analysis: Techniques, Applications and Computations at the University of Cambridge, UK
September to December 2019 and the organiser of the Computational Complex Analysis Workshop hosted by the University of Cambridge, UK in December 2019.

SERVICE TO THE SCIENTIFIC COMMUNITY

Dr Dirk Basson was the local organiser for AIMS-Stellenbosch Number Theory Seminar held at Stellenbosch University, 14-18 January 2019.

Dr Ronalda Benjamin was a member of the local organising committee of the international conference "Positivity X", 8-12 July 2019; one of the organisers of the special session on Functional Analysis and Operator Theory at the SAMS conference, 2-4 December 2019.

Prof Andries Engelbrecht was a PC member for the Genetic and Evolutionary Computation Conference. He also attended and presented at the following conferences: the IEEE Congress on Evolutionary Computation; the International Conference on Swarm Intelligence; the Artificial Evolution Conference; the SA Forum for Artificial Intelligence Research Conference; the ACM/SIGEVO Workshop on Foundations of Genetic Algorithm; the International Joint Conference on Neural Networks; a workshop on Computational Intelligence at the German Conference on Artificial Intelligence; the International Conference on Machine Learning, Optimization and Data Science; the International Conference on Multiple Objective Programming and Goal Programming; the IEEE Symposium Series on Computational Intelligence; and the International Conference on the Theory and Practice of Natural Computing.

Prof Bernd Fischer chaired the steering committee of the "Automated Software Engineering" conference series and served as a member of the Program Committee and Board of the International Conference on Automated Software Engineering (ASE) and the International Conference on Software Engineering (ICSE). He also co-organised the Workshop on Advances in Knowledge Engineering, Reasoning, and Sensemaking (WAKERS) in Stellenbosch.

Prof Nick Hale and **Prof Ingrid Rewitzky,** together with Prof Paul Mostert, secured the bid for the fifth BRICS Mathematics and Statistics Conference to be hosted in Stellenbosch in 2021/2022. The conference will be jointly organised by the Stellenbosch University Department of Mathematical Sciences and Department of Statistics and Actuarial Science, and will act as the annual meeting for the South African Mathematics Society (SAMS), South African Numerical and Applied Mathematics (SANUM), and the South African Statistical Association (SASA). This conference aims to build purposeful partnerships and inclusive networks for mathematicians, applied mathematicians, and statisticians from across BRICS and Africa to leverage the strength of individuals and unlock new opportunities for emerging researchers and students.

Dr Karin-Therese Howell was the convenor of the organising committee for the African Women in Mathematics Conference 2-5 July 2019 with Dr Ronalda Benjamin, Dr Retha Heymann, Dr Sophie Marques, Ms Lesley Wessels as members of the local organising committee.

Prof Zurab Janelidze served on the scientific committee of the International Category Theory Conference held at the University of Edinburgh, Scotland, in June 2019.

Dr Steve Kroon served as a programme committee member for the International Conference on Machine Learning 2019 and the Neural Information Processing Systems 2019 conference.

Prof Brink van der Merwe served as programme committee member for the 11th International Workshop on Non-Classical Models of Automata and Applications, as well as for the 24th International Conference on Implementation and Application of Automata.

EDITORIAL ACTIVITIES

Prof Andries Engelbrecht is associate editor of the following journals: *IEEE Transactions on Neural Networks and Learning Systems, IEEE Transactions on Evolutionary Computation, Swarm Intelligence Journal, Engineering Applications of Artificial Intelligence and Complex Systems.*

Prof Bernd Fischer is editorial board member of the journal *Science of Computer Programming,* responsible for the software section.

Prof Zurab Janelidze is a member of the editorial board of the journals *Cahiers de Topologie et Géométrie Différentielle Catégoriques* and *Applied Categorical Structures.*

Prof Ingrid Rewitzky is associate editor of *Quaestiones Mathematicae.*

Prof André Weideman is associate editor of the journals *Numerical Algorithms* and *Electronic Transactions of Numerical Analysis.* He also serves on the editorial board of *Quaestiones Mathematicae.*

Prof Helmut Prodinger is a member of the editorial boards of *Theoretical Computer Science, International Journal of Intelligent Computing and Cybernetics, Universal Computer Science, The Pioneer Journal of Advances in Applied Mathematics.*

Prof Brink van der Merwe and **Prof Lynette van Zijl** are editorial board members of the *Journal of Universal Computer Science.*

Prof Willem Visser is editorial board member of the *journal of the Association for Computing* (ACM).

Prof Stephan Wagner is member of the editorial boards of the journals *Afrika Matematika, Applicable Analysis and Discrete Mathematics, Communications in Combinatorics and Optimisation, Journal of Integer Sequences, MATCH Communications in Mathematical and in Computer Chemistry, Quaestiones Mathematicae and Theory and Applications of Graph.*

ACADEMIC AFFAIRS

As part of the programme renewal project in the Faculty of Science, the Mathematical Sciences programme committee has been rethinking the Mathematical Sciences Programme and strengthening teaching and learning in machine learning and data science. The Applied Mathematics Division, in consultation with Prof Ulrich Paquet (extraordinary professor in the department and Research Scientist at Deep Mind) and colleagues from Computer Science and Electric and Electronic Engineering, have set up a world-class structured MSc in Machine Learning and Artificial Intelligence to be offered at SU from 2021.

The Computer Science Division is expanding their offering to fulfil the need for a wide spectrum of computer professionals in South Africa and beyond and a new programme BSc in Computer Science has been proposed to replace the existing stream of the BSc in Mathematical Sciences. This programme, to be offered from 2021, will increase the visibility of Computer Science at SU and will include a data science curriculum.
The Mathematics Honours programme was strengthened with 8-credit modules providing a solid foundation in each of the core research areas in the Mathematics Division. Discussions are underway for these modules, with the appropriate level of assessment, to be offered as part of a structured MSc in Mathematics with a global education perspective through the ALGANT programme and collaboration with among others, the Computer Algebra Group at the Technical University Kauserslautern.

The Biomathematics Honours focus offered in partnership with AIMS-SA has been sustained with a good source of South African postgraduate students for the SARChI Research Chair in Mathematical and Physical Biosciences and for SACEMA. While the Biomathematics undergraduate streams have been retained with the specialised third year project in Biomathematics, the biomathematics undergraduate modules (one at second-year and two at third-year) have been phased out. The reason for this is to retain a research component in the stream while making use of other existing modules to provide a broad foundation in mathematical and computational techniques. This has also allowed the Mathematics Division to place more emphasis on the core Mathematics undergraduate modules.

The Department of Mathematical Sciences will be involved in offering modules in Applied Mathematics, Computer Science, and Mathematics for three new multidisciplinary programmes:

- Postgraduate diploma in Biomedical Engineering and MSc in Biomedical Engineering, to be conferred by the Faculty of Engineering;
- Bachelor in Data Science – the first undergraduate programme to be offered jointly by the Faculties of Science and Economic Management Sciences; and
- BSc Honours as well as the undergraduate curriculum in Bioinformatics and Computational Biology.

NRF-rated researchers		
Leading international researchers	Prof H Prodinger	Analysis of algorithms, number theory and combinatorics
	Prof W Visser	Software failure, software engineering and software development
Internationally acclaimed researchers	Prof B Fischer	Software engineering
	Prof Z Janelidze	Category theory
	Prof L Van Wyk	Ring theory and matrix algebras
	Prof S Wagner	Graph theory and combinatorics
	Prof JAC Weideman	Graph theory and combinatorics
Established researchers	Dr J Geldenhuys	Software engineering and specifically model checking and process algebra
	Prof S Mouton	Software engineering and specifically model checking and process algebra
	Prof AB van der Merwe	Automata theory
	Prof L van Zijl	Theoretical computer science and assistive technologies
Promising young researchers	Dr G Boxall	model theory and applications
	Prof Sonia Fidder-Woudberg	fluid modelling
	Dr J Gray	category theory
	Dr T Grobler	remote sensing data
	Dr Nick Hale	numerical analysis and scientific computing
	Dr K-T Howell	near vector spaces
Prestigious awardee	Prof C Hui	Mathematical and theoretical physical biosciences

COLLABORATION

Australia
Griffith University
Austria
Johannes Kepler University Linz
Technical University of Graz
Belgium
Université Catholique de Louvain
University of Louvain-la-Neuve
Canada
University of Ontario Institute of Technology
University of Victoria
Cyprus
University of Cyprus
France
IMT Atlantique
University of Bordeaux
University of Nice
University of Paris
University of Paris-Sud
Germany
Braunschweig-University-of-Technology
Humboldt University, Berlin
India
Indian Institute of Technology Roorkee
Italy
University of Molise
University of Padova
Poland
Gdansk University of Technology
Warsaw University of Technology
Portugal
University of Algarve
South Africa
Council for Scientific and Industrial Research (CSIR)
University of Cape Town
University of Pretoria
University of South Africa
University of the Witwatersrand
Spain
Institute of Agriculture and Food Research and Technology, Barcelona
Rey Juan Carlos University
Sweden
Sweden University Forum (SASUF)
Umeå University
Switzerland
University of Basel
The Netherlands
University of Groningen
United Kingdom / Ireland / Scotland
Aberystwyth University
Brock University
Imperial College London
UK Royal Academy of Engineering HeP SSA
University of Cambridge
University of Central Lancashire
University of Manchester
University of Sterling
United States
NASA Ames Research Center

FUNDING

South Africa
DSI-NRF Centre of Excellence in Mathematical and Statistical Sciences, South Africa
National Research Foundation Incentive Funding, South Africa
National Research Foundation CPRR Funding, South Africa
National Research Foundation Funding for CNRS/NRF Research collaboration (South African funding to supplement CNRS funding from France for collaborations between South African, French, Madagascar and Danish mathematicians working in Geometry and Number Theory (GANDA))
New Generation of Academics Programme (nGAP)
NIThePVisitor Grant: Dr Gregoire Ferre, University of Paris-Sud, France
Rubbi Fund, South Africa
SARChI Grantholder Funding, South Africa
Sabbatical grant: HB Thom Foundation, South Africa
South African - Sweden University Forum for collaboration grant "Prehospital Resource Optimization"
South Africa - Sweden University Forum (SASUF) collaboration grant "Network Testing and Fuzzing for a Reliable and Secure Internet of Things", with Uppsala U [Sweden], KTH Stockholm [Sweden], CUT
Stellenbosch University Staff mobility grant, South Africa
Stellenbosch University Subcom B grant, South Africa

International
Engineering and Physical Sciences Research Council (EPSRC), United Kingdom
European Coimbra Group Short Stay Scholarship for young researchers from Sub-Saharan Africa
Erasmus + Exchange, Poland
Erasmus+ Mobility Grant, Czech Republic
Global Challenges Network, United Kingdom
UK Royal Academy of Engineering
Université catholique de Louvain

AWARDS TO STAFF AND STUDENTS

Prof Bernd Fischer with his students Jan Taljaard and Moeketsi Raselimo received an ACM Distinguished Paper Award at the 12th International Conference on Software Language Engineering (SLE 2019) for their paper "Breaking Parsers: Mutation-based Generation of Programs with Guaranteed Syntax Errors". This award is given to the best 10% of papers at a conference.

Prof Cang Hui received Stellenbosch University Research Excellence awards for the number of research output and number of research output units delivered in 2018.

Dr Steve Kroon received, with S.A. Cameron and H.C. Eggers, the second prize poster at MaxEnt 2019 in Garching, Germany, for the poster "A Sequential Marginal Likelihood Approximation Using Stochastic Gradients" and received, with A. Pretorius, E. van Biljon, R. Eloff, M. Rynard, B. van Niekerk, S. James, B. Rosman, H. Kamper, the poster prize at 2019 Deep Learning IndabaX South Africa (Durban) for the poster "Dropout Initialization". The latter is unpublished work, in collaboration with colleagues at University of Witwatersrand.

Prof Helmut Prodinger received a Stellenbosch University Research Excellence award for the number of research output units obtained in 2018.

Prof André Weideman was awarded the South African Mathematical Society award for Research Distinction. The award, in the form of a silver Mobius band, serves to recognise and stimulate excellence in research. It is only made in recognition of important research contributions to Mathematics or to the applications of Mathematics in any field.

At the Annual Prize giving Event in 2018 for Computer Science Students awards were presented to Brendan Keith and Mark Watling (best first year), Caleb Russell Zeeman (best second year), Jacobie Christina Mouton (best third year), Johannes Coetzee (best honours student), Sedick David Baker Effendi (best Honours project); Heinrich Cilliers (best data science honours student) and Ryan Lang (best machine learning student).
Top achievers in Applied Mathematics for 2018 academic year were rewarded for their hard work with certificates and book prizes sponsored by Cambridge University Press. They are Emma Nel (best first year), Jacobie Mouton (best second year), Freddie de Villiers (best third year) and Esmari Maré (best honours student).
The following students will be receiving the Rubbi Prize book in Mathematics: Muhammad Dollie and Wicus van der Linden (best first year students), Jacobus Olivier and Jean Louise van der Walt (best first year engineering mathematics students), Eugene Fouche and Joshua Putterhill (best second year students), Dario Trinchero and Conrad Strydom (best third year students) and Nicola Brill and Andrew Harrison-Migochi (best honours students).

Sarah Selkirk pictured here after the SU December 2019 graduation ceremony. *Photo: Stefan Els*

Harrison-Migochi

Andrew Harrison-Migochi received the SAMS Bronze medal in recognition for being the best honours student in Mathematics in SA in 2019.

Jacoline van Jaarsveld received the John Todd Morrison medal for the top masters student in Applied Mathematics (2017-2018). She completed her MSc under the supervision of Dr Sonia Fidder.

Sarah Selkirk was awarded one of three TATA masters scholarships at the South African Women in Science Awards as well as the prestigious S_2A_3 medal for the best MSc student at Stellenbosch University (SU) in the natural, engineering and medical sciences. The S_2A_3 Masters Medals (bronze) have been awarded annually since 1981 by the Southern Africa Association for the Advancement of Science to the most outstanding research student in a scientific subject per South African university. Founded in 1902, it is the oldest scientific organisation in South Africa. Selkirk worked largely independently to complete her MSc thesis in only one year, with two papers resulting from her mostly original work already accepted for publication. After her graduation in December 2019, she went to Austria where she will continue with her doctoral research in the field of combinatorics at the University of Klagenfurt.

STAFF MATTERS

Three staff members were promoted from Senior Lecturer to Associate Professor: Dr Willie Brink (Applied Mathematics), Dr Sonia Fidder (Applied Mathematics), and Dr Steve Kroon (Computer Science).

During 2019 there were two resignations: Prof Stephan Wagner (Mathematics, 2007-2019) accepted the appointment of Professor of Mathematics at the University of Uppsala, Sweden, and Prof Willem Visser (Computer Science, 2009-2019) accepted the appointment of Senior Principle Research Scientist at Amazon. Prof Wagner will continue his affiliation to the department as an Extraordinary Professor and Prof Visser will retain a 1/8 appointment in Computer Science.
Mr Mkhuseli Ngxande took up the position of lecturer in Computer Science with effect from 1 June 2019. He completed his undergraduate, honours and masters studies in Computer Science at the University of Fort Hare.

Dr Arnold Keet, who was appointed at Stellenbosch University on 1 October 2002, retired at the end of 2019. Apart from having a broad and deep knowledge of his own field of Algebraic Number Theory, Dr Keet is an extremely widely read intellectual. He made a point of attending almost all departmental seminars and colloquia, which is very rare in most departments. Dr Keet was a mentor to younger staff members. His first thought in departmental meetings was invariably towards the careers of others and not his own. He was a committed and patient teacher, never cutting corners. He always chose examples for his lectures extremely carefully and explained them slowly and methodically to the students. Similarly, when Dr Keet gave research seminars, the attendees always found, upon later reflection, that he had chosen the very best approach which cuts to the heart of the matter.

Mr Brian Jacobs announced his retirement effective 1 March 2020 after 38 years of dedicated service to Stellenbosch University – 17 years in the Department of Accounting and the past 21 years in the Mathematics Division (formerly Department of Mathematics).

Dr Steve Kroon has been selected as one of the inaugural Jane Street Depth First Learning fellows. Depth First Learning is an initiative to develop lesson plans building up to mastery of significant research papers while running study groups on the required material. Dr Kroon will be coordinating a group for the paper "Variational Inference with Normalizing Flows", by Danilo Rezende and Shakir Mohamed.

Prof Willie Brink took up the two-year appointment as Division Head of Applied Mathematics with effect from 1 January 2019. Prof Leon van Wyk resumed the second year of his appointment as Division Head of Mathematics, from 1 July 2019 to 30 June 2020. Prof Ingrid Rewitzky was re-appointed the Executive Head of the Department of Mathematical Sciences, from 1 January 2020 to 31 December 2022. Prof Bernd Fischer was re-appointed head of the Division of Computer Science, from 1 January 2020 to 31 December 2021.

STAFF LIST

Academic

Dr B Bah (jointly with AIMS-SA)
Dr B Bartlett
Dr DJ Basson
Dr R Benjamin
Mr W Bester
Dr G Boxall
Dr W Brink
Mrs EJ Burger
Dr H Coetzer
Dr M Cloete
Dr A de Villiers
Dr H Diedericks
Prof A Engelbrecht (joint appointment with the Department of Process Engineering)
Dr S Fidder-Woudberg
Prof B Fischer (Division Head: Computer Science)
Prof J Geldenhuys
Dr JRA Gray
Dr N Hale
Dr R Heymann
Dr K-T Howell
Prof C Hui (SARCHi)
Dr CP Inggs
Dr Z Janelidze
Dr A Keet
Dr S Kroon
Dr MF Maritz
Dr J Masuret
Prof S Mouton
Mr S Mungwe
Mr M Ngxande
Prof H Prodinger
Dr D Ralaivaosaona
Prof IM Rewitzky (Executive Head)
Dr R Roux
Prof F Smit (Division Head: Applied Mathematics)
Prof H Touchette
Prof AB van der Merwe
Prof L van Wyk (Division Head: Mathematics)
Prof L van Zijl
Prof WC Visser
Prof S Wagner
Prof JAC Weideman
Ms L Wessels
Prof M Wild

Extraordinary appointments

Prof J Bishop (Extraordinary Professor, Computer Science)
Prof B Herbst (Extraordinary Professor, Applied Mathematics)
Dr M Hoffmann (Extraordinary Senior Lecturer, Computer Science)
Dr U Paquet (Extraordinary Professor, Applied Mathematics)
Prof H-E Porst (Extraordinary Professor, Mathematics)

Emeritus professor

Prof AE Krzesinski

Support staff

Mrs L Adams
Mrs H du Plessis
Mrs V du Plessis
Mrs S Fortuin
Mrs W Isaacs
Mr B Jacobs
Mrs L Muller
Mr A Roman
Mr D Stephanus

Postdoctoral Fellows

Dr Luca Demangos
Dr Genevieve Diedericks
Dr Pietro Landi
Dr Guillaume Latombe
Dr Henintsoa Onivola Minoarivelo
Dr Olugbenga O. Oluwagbemi
Dr James G. Rodger
Dr Wolf-Christian Saul
Dr Mario Mairal

SOCIAL IMPACT

Dr Dirk Basson organised Boland team's participation in the South African Mathematics Team Competition (for high school learners) and the December Olympiad training camp for 40 high school learners and 10 coaches, 9-13 December. He is also a South African Mathematics Olympiad committee member involved in setting and marking the third round of the national Olympiad.

Prof Willie Brink visited the University of Mauritius in December 2019 to present a practical introduction to deep learning to students, and gave a public talk at the Human Resource Development Council of Mauritius.

Prof Bernd Fischer mentored a staff member of the University of eSwatini as part of the UK Royal Academy of Engineering Higher Education Partnerships in sub-Saharan Africa (HEP SSA) grant "A framework for creating, transferring, commercialising and exchanging knowledge within and between sub-Saharan universities and industries". He also secured the laptop donation to First and Second year BCI Computer Science students by Payat.

Dr Steve Kroon co-authored, with W. Brink, H. Kamper, S. Kroon, U. Paquet, and H. Touchette, an article "Teaching for the Future" in the magazine *Synapse*. He also co-ordinated an online study group on normalising flows as recipient of an inaugural Jane Street Depth First Learning Fellowship, with participants from Germany, India, Poland, Senegal, United

Kingdom and South Africa.
Prof Hugo Touchette gave a Science Cafe public talk on "How connected are you? An introduction to graph theory and network science", May 2019.

Prof Lynette van Zijl established cooperation with the Landmark Foundation on nature conservation image processing. She also mentored a staff member of the University of eSwatini as part of the UK Royal Academy of Engineering Higher Education Partnerships in sub-Saharan Africa (HEP SSA) grant "A framework for creating, transferring, commercialising and exchanging knowledge within and between sub-Saharan universities and industries"
"From the Earth to the Moon" was a public lecture extravaganza on 1 August 2019 organised by Dr Bruce Bartlett, with the assistance of the faculty's science communicator Wiida Fourie-Basson, to mark the 50th anniversary of the Apollo 11 moon landing on 20 July 1969. The event was a huge success, with the venue filled to capacity (368 members of the public), including five groups of schoolchildren, who were given individual historical roles to play as Mission Controllers. The speakers were Dr Milton Maritz, Prof Pieter Maritz, Prof Hansie Knoetze, Dr Bruce Bartlett and Prof Willem Visser, and hosted by Dr Gillian Arendse. At the end of the evening, there was also a showing of the Apollo 11 documentary in the Pulp Cinema.
Several of our staff members featured in the media:

- **Dr Bruce Bartlett,** interviewed by John Maytham on Cape Talk about "South Africa's voter turnout - a mathematician runs the numbers", an article he wrote for The Conversation Africa, 27 May 2019. Dr Bartlett was also interviewed, on the same show, to promote the upcoming "From The Earth to The Moon" public lecture on 1 August 2019.
- **Dr Sonia Fidder** was interviewed on Nuus om 8 Perspektief, an Afrikaans live News broadcasting DSTV channel, as part of the International Day of Women and Girls in Science, Feb 2019.
- **Dr Karin Howell** gave interviews to IOL, The Citizen, The Star, Cape Argus, Cape Times, GoodHope FM, and Smile 90.4 FM about the African Women in Mathematics Conference.
- **Prof Ingrid Rewitzky** gave a live eNCA interview on her journey as a mathematician and on the legacy of the African Women in Mathematics Conference.
- **Prof Leon van Wyk** was interviewed by the Afrikaans radio station RSG on the Fibonacci Sequence and the Golden Ratio, 10 October 2019

The **Psychology of Abstract Mathematics Project** was founded by Dr Sophie Marques and initiated together with Dr Karin Howell, Prof Zurab Janelidze and Prof Ingrid Rewitzky. The goal is to rethink learning and teaching of mathematics to promote in-depth understanding but also raise great human beings with empathy and the will to make positive changes in society. Bringing mathematics and psychology together raises a human side to mathematics making it more accessible while understanding and addressing the associated anxieties. Students, mathematicians, teachers, psychologists, educationalists, and others interested in mathematics engage in quarterly discussions with a relevant theme. During 2019 there were four discussions: "The Psychology of Abstract Mathematics project" on 19 May; "Should we care to understand? Who is the master of our own curiosity?" on 19 June; "The human side of mathematics. How important is it to pass from intuition to a formal definition, precise statement and formal proof?" on 14 August; "How could research and teaching come together? Should we promote collaboration or competition? " on 25 September.

For the dissemination of the perspectives expressed in these discussions, a magazine **WISAARKHU** was launched. The aims are to provide a diversity, not necessarily a jointly exhaustive collection, of perspectives on relevant themes related to the learning and teaching of Mathematics and to provide a platform for inspiring, creating awareness, sharing experiences, communicating, connecting, and reflecting.

The annual **South African Mathematical Modelling Contest** (SAMMC), organised by Dr Andie de Villiers, Prof Nick Hale and Dr Riana Roux, provides South African undergraduate students in science and engineering disciplines some exposure to applied mathematics problems more relevant to real-world applications than they might otherwise encounter in the classroom. It is a chance to challenge their brain and develop problem-solving skills, gain experience in working in a team, and possibly win some prizes. This initiative is funded through the DSI-NRF Centre of Excellence in Mathematical and Statistical Sciences and Opti-Num solutions. The format of the contest is loosely based on the international COMAP MCM competition, held every January. A secondary aim of SAMMC is to gain experience

in solving MCM-type problems and to help select teams for the international

competition. SAMMC2019 had 17 teams from four universities successfully complete the contest. Of these 17, eight were graded as successful participants (three from Stellenbosch and UKZN, and one each from WITS and UP). Three teams chose problem A (James Bond car stunt), three chose problem B (Art gallery security), and two chose problem C (fisheries).

Colleagues have been involved in activities of the **African Institute of Mathematical Sciences** (AIMS-SA):

- A skills course on Mathematical Problem Solving was presented by Dr Naina Ralaivasosaona and Prof Stephan Wagner;
- Structured masters research projects were supervised: 'Model theory of algebraically closed fields and the Ax-Grothendieck theorem' by Ahmed Elmwafy (co-supervised by Dr Gareth Boxall and Dr C. Kestner); 'An introduction to Beidleman near vector spaces' by Antsa Rakotondrafara (supervised by Dr Karin Howell); 'On elliptic curve cryptography' by Tamara Tembo (supervised by Dr Sophie Marques); 'On proving Serre's homological criterion for regularity of Noetherian local ring' by Ali Traore (co-supervised by Dr Sophie Marques and Dr N.P. Strickland).

The sixth annual Computer Science Career Fair was held on 5 August 2019 with the goal of facilitating interaction between potential employers and students. Involvement in enrichment activities for prospective students, include:

- **Dr Ronalda Benjamin** was a guest speaker at the Cape Winelands Education District Math Conference 2019 (for Grades 1 to 9 Mathematics teachers), Montana High School, 7 September 2019 and an invited speaker at the SUNCEP Learning Enhancement Strategic Plan Workshop, Stellenbosch University, 16 November 2019.
- **Dr Gareth Boxall** coordinated the Patterns of the World initiative to expose prospective students to the importance and possibilities of Mathematics in the study of Science.
- **Dr Karin Howell** continued her outreach to girl learners at schools visiting Abbotts College, January 2019; Herschel Girls' High, February 2019; Somerset College Grade 6 and 7, Somerset College, May 2019; Somerset College Prep teachers and parents, July 2019; Redham Constantia, Grade 11 and 12, September 2019; Rustenberg Girls' High to the Grade 9 learners, December 2019.
- **Dr Riana Roux** has developed two Science Spaza worksheets on Graph Theory for high school science clubs throughout South Africa.

Prof Lynette van Zijl sustained cooperation with Pioneer School in Worcester for software development to support teaching to sight-impaired children.
The Stellenbosch University Mathematics Society (SUMS) was established in 2019 by MSc-student Sarah Selkirk. This society organises a weekly undergraduate mathematics seminar which features interesting and accessible mathematics topics not covered in the undergraduate syllabus. The presenters are researchers in Mathematics at Stellenbosch University, affiliated researchers, as well as former postgraduate students.

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No. 57

SCIENCE SPAZA

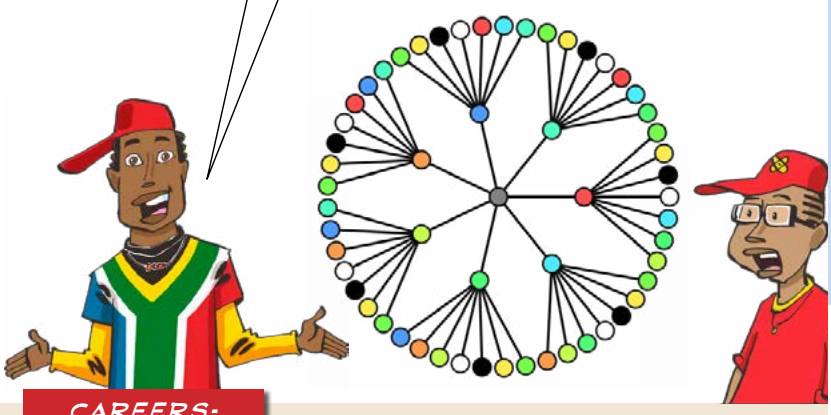
www.sciencespaza.org

COLOURFUL MATHS

MATHS IN SOCCER?!?

SOUTH AFRICA'S AMAZING MATHS

MATHEMATICIANS AT THE **UNIVERSITY OF STELLENBOSCH**, RIGHT HERE IN SOUTH AFRICA, ARE RESEARCHING GRAPH THEORY. THEY ARE DISCOVERING SO MANY WAYS THAT IT CAN BE USED TO MAKE LIFE A WHOLE LOT SIMPLER, SUCH AS DEVELOPING MATHS THAT HELPS TO FIND THE BEST PLACES TO BUILD NEW WAREHOUSES OR CLINICS. THEY EVEN USE GRAPH THEORY TO KEEP COMMUNITIES SAFE BY FIGURING OUT HOW MANY FIRE TRUCKS SHOULD BE AT EACH FIRE STATION IN A CITY. **WHO SAID MATHS IS BORING?!**



CAREERS:

Data scientists take data (inFormation) that has been collected From observing something or From research - and make sense oF it. The statistics From a soccer match will be analyzed by a data scientist.

Operation Research Analysts use their maths and reasoning skills to solve problems and provide solutions. They may use graph theory to improve a schedule or process. A business will hire them to improve their business practises.

Mathematicians can become **teachers** or **lecturers**. While teachers work in schools, lecturers work at tertiary education Facilities, like a university. These are awesome careers as you get to pass on knowledge to the next generation!

Klara Kleinhans is an Honours student at Stellenbosch University. She has a degree in Mathematical Science and is using maths to figure out what the best option for setting up cell phone towers is. Amazing! Klara finds maths makes her curious, and she loves the challenge of using maths to solve real life problems. She says "maths does not discriminate, and anyone can learn".

CURRICULUM LINKS

- *Grade 7, 8 and 9: Mathematics - Numbers, Operations and Relationships:* Numeric and Geometric Patterns - Investigate and extend patterns, input and output values.

Knowledge is Ncah!

TOURNAMENT ORGANISER!

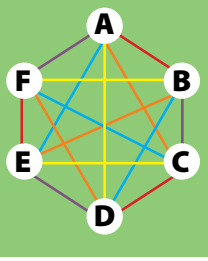
IN THIS ACTIVITY YOU ARE GOING TO ORGANISE AND PLAY A COIN FLIPPING TOURNAMENT.

1. FIND 5 FRIENDS TO PLAY THE TOURNAMENT WITH YOU. FILL IN THEIR NAMES ON THE "NAME" TABLE.

	Name
A	
B	
C	
D	
E	
F	

2. USE THE COLOUR GRAPH TO FILL IN THE "MATCH" TABLE. EACH COLOUR ON THE GRAPH IS ONE ROUND. EACH LINE BETWEEN PLAYERS SHOWS WHO NEEDS TO PLAY EACH OTHER IN THAT ROUND.

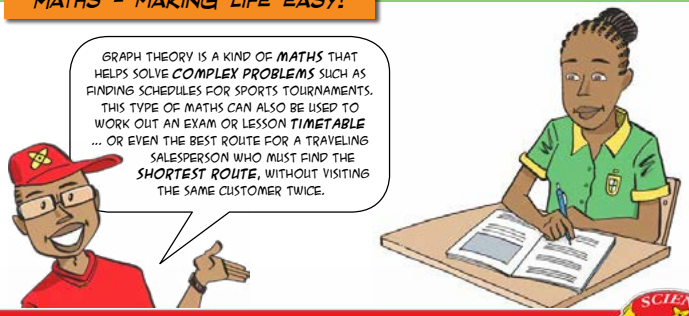
Matches				
Round 1	Round 2	Round 3	Round 4	Round 5
__ plays __	__ plays __	__ plays __	__ plays __	__ plays __
__ plays __	__ plays __	__ plays __	__ plays __	__ plays __
__ plays __	__ plays __	__ plays __	__ plays __	__ plays __



3. PLAY THE MATCHES. EACH MATCH INVOLVES 2 PEOPLE. ONE PERSON FLIPS A COIN, AND THE OTHER SAYS "HEADS" OR "TAILS". IF THE CALLER GETS IT RIGHT, THEY WIN, IF THE CALLER GETS IT WRONG, THE OPPONENT WINS. EACH MATCH IS THE BEST OF 3 COIN FLIPS. THE WINNER GETS 1 POINT; THE LOSER GETS NO POINTS.

4. COUNT UP YOUR POINTS TO SEE WHO THE OVERALL WINNER IS AT THE END OF ALL THE MATCHES. IF SOME PEOPLE HAVE THE SAME NUMBER OF POINTS, PLAY AN EXTRA KNOCKOUT ROUND - IF YOU LOSE YOU ARE OUT.

MATHS - MAKING LIFE EASY!

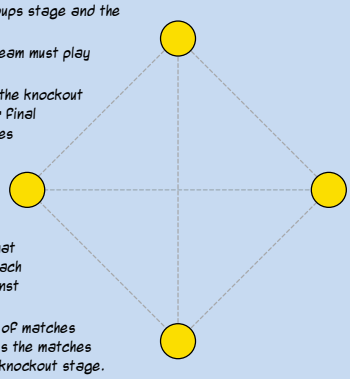


HOW MANY GAMES?

There are 16 teams split into 4 groups.
There are two stages – the groups stage and the knockout stage.
During the group stage, each team must play each other once.
The top 2 teams go through to the knockout stage which starts with quarter Final matches, then semi-Final matches and then the Final match.

Colour the lines in the graph to work out how many matches are necessary For the group stages. Remember that each colour is one round and each line shows who should play against each other.

Then work out the total number of matches in the tournament, which includes the matches played in the group stage and knockout stage.



Answer: 6 matches per group = 24 matches. Quarter finals = 4 matches. Semi-finals = 2 matches. finals = 1 match. TOTAL = 31 matches

START YOUR OWN SCIENCE SPAZA

Do you want to start a science club at your school? Send us the following information, and Science Spaza will contact you.

School: _____

Name: _____

Telephone number: _____

Email address: _____

Postal address: _____

_____

_____

_____

Visit www.sciencespaza.org, email info@sciencespaza.org, sms or WhatsApp us on 076 173 7130 or write to us at PO Box 22106, Mayor's Walk, 3208.

WE WANT YOUR FEEDBACK!

SEND US SOME PHOTOS OF THE COIN FLIPPING TOURNAMENT YOU PLAYED. YOU CAN WHATSAPP THEM TO 076 173 7130.

MaSS DSI-NRF CENTRE OF EXCELLENCE IN MATHEMATICAL & STATISTICAL SCIENCES

UNIVERSITEIT STELLENBOSCH UNIVERSITY 100 1918 · 2018

Jive Media Africa

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YAZI CENTRE FOR SCIENCE & SOCIETY IN AFRICA

DEPARTMENT OF MICROBIOLOGY

RESEARCH INTERESTS

Bioprocessing
Enzyme engineering and bioinformatics
Lactic acid bacteria
Microbial ecology and mycology
Water treatment
Fungi biotechnology for bioenergy and the bioeconomy
Functional microbial bioinformatics
Biotechnologies for water treatment
Interactions of opportunistic pathogens
Biofilm ecology

RESEARCH HIGHLIGHTS

Postgraduate students share findings on AIDS-related mycosis

Four postgraduate students presented their latest findings at an international workshop on AIDS-related mycosis that was hosted by the AFGrica Medical Mycology Research Unit at the University of Cape Town from 10 to 12 July.

MSc students Caylin Bosch, Zoe Bhana and Shakier Samie presented their posters to delegates from more than 14 countries, while PhD student Barbra Toplis presented a talk at the workshop. There were altogether 31 speakers of the workshop, seven from South Africa and 24 from other countries.

Annual yeast colloquium provides platform for knowledge sharing

The annual Yeast Colloquium, organised by our colleagues at SU's Institute of Wine Biotechnology (IWBT), was held during July 2019. This one-day event was attended by more than 60 students and postdoctoral fellows from the research groups of Prof Emile van Zyl, Prof Alf Botha and Dr Heinrich Volschenk, as well as Prof Florian Bauer (IWBT) and Prof Riaan Den Haan, University of the Western Cape. The goal of the Yeast Colloquium is to provide postgraduate students and postdoctoral fellows a unique platform to share their research and exchange valuable information on techniques, thus promoting collaboration between the yeast-based research groups in the country especially in the Western Cape.

PhD student's paper selected as one of top 10%

An article by one of Prof Wesaal Khan's PhD students, Brandon Reyneke, titled "*Podoviridae* bacteriophage for the biocontrol of *Pseudomonas aeruginosa* in rainwater," was selected by the handling Editor as one of the top 10% of papers published in the journal *Environmental Science: Water Research and Technology*. This selection was based on the exceptionally positive referee reports that the manuscript received during peer review, along with the Editor's assessment of the significance and impact of the paper.

WHO's first Antibiotic Week symposium in South Africa

Prof Wesaal Khan was part of the organising committee for the first World Health Organisation (WHO) World Antibiotic Week symposium presented at the University of Johannesburg in November 2019. Titled "Antibiotic resistance and one health – novel strategies in antimicrobial research", the symposium was jointly hosted by the Faculty of Health Sciences at the University of Johannesburg, the Water Research Commission of South Africa and SU's Department of Microbiology. It is envisaged that the event will be presented on an annual basis.

The first World Health Organisation (WHO) World Antibiotic Week symposium was held in South Africa during November 2019.

RESEARCH ACTIVITIES

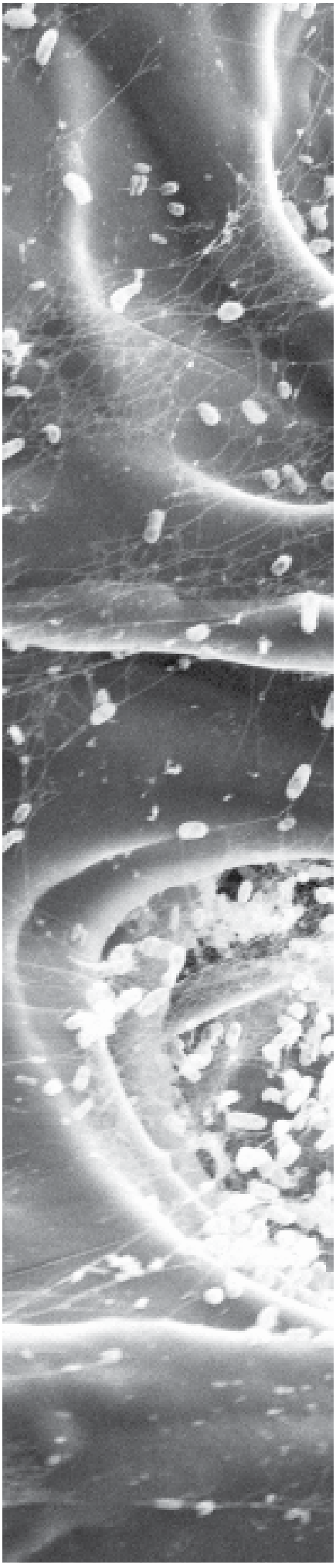
Prof Gideon Wolfaardt hosted a group of 12 collaborators from the University of Bath, United Kingdom, as part of the project "Developing resilient nations – towards a public health early warning system via urban water profiling". During 2019 he also hosted a group of five collaborators from the University of Oslo and two commercial partners from Norway, Hearing Strategy and Advice and ecologIQ as part of the project "Mapping of sources, measures and environmental impacts of plastics in riverine and marine habitats". Other international visitors were Dr Endré Horvat from Ecole Polytechnique Fédérale de Lausanne, Switserland, and Prof Steven Liss, Vice-President Research from Ryerson University, Canada.

Prof Wesaal Khan co-hosted with South African partners, collaborators from Germany, Spain and Italy as part of our Europen Union Horizon 2020 project, "SafeWaterAfrica".

SERVICE TO THE SCIENTIFIC COMMUNITY

Prof Alf Botha is a member of the editorial board of *FEMS Yeast Research* (2008 to the present) and also acts as an editor of the *Canadian Journal of Microbiology* (associate editor since 2011).

Prof Leon Dicks serves on the editorial boards of the journals *Probiotics and Antimicrobial Proteins* (associate editor from 2008 to the present), *Beneficial Microbes* (associate editor, from 2008 to the present), *Annals of Microbiology* (2013 to the present)



as well as *Bioscience of Microbiota, Food and Health* (2011 to the present). The latter is the joint scientific journal of the Japan Bifidus Foundation, the Japanese Association for Food Immunology and the Japan Society for Lactic Acid Bacteria. Prof Dicks serves as Chief Editor of the *South African Journal of Enology and Viticulture* (editor since 2005).

Prof Karen Jacobs is a member of the editorial boards of *Mycology: An International Journal of Fungal Biology* (Taylor and Francis) and *Bothalia* (AOSIS).

Dr Heinrich Volschenk serves as vice-president of the South African Society for Microbiology (SASM) (2018-present).

Michelle Rossouw received the SU Rector's Award for excellent academic achievement. With her is Prof Louise Warnich, Dean of the Faculty of Science. Photo supplied

AWARDS TO STAFF AND STUDENTS

Prof Emile van Zyl was awarded the SU Rector's award for Excellence in Research on 11 December 2019.

ACADEMIC AFFAIRS

During 2019 the Department had a full cohort of postgraduate students: 11 Honours, 25 MSc and 22 PhD students.

NRF-RATED RESEARCHERS		
Internationally acclaimed researchers	Prof LMT Dicks	Probiotics and antimicrobial peptides of lactic acid bacteria; nano-biosensor point-of-care devices
	Prof WH van Zyl	Yeast biotechnology with a focus on cellulosic ethanol and biorefineries (SARChI Chair)
	Prof GM Wolfaardt	Applied and environmental microbiology
	Prof A Botha	Yeast ecology
Established researchers	Prof Heinrich Volschenk	Functional bioinformatics for yeast biotechnology
	Prof K Jacobs	Microbial ecology and taxonomy
	Prof W Khan	Innovation in rainwater treatment and monitoring; biosurfactants as alternative antimicrobials and antifouling agents
	Prof M Viljoen-Bloom	Agrobioprocessing with microbial enzymes for the production of biofuels and high-value chemicals

COLLABORATION

South Africa

Agricultural Research Council (PPRI)
Council for Scientific and Industrial Research (CSIR)
Division of Medical Microbiology, Faculty of Health Sciences, University of Cape Town
Elsenburg Agricultural College
East Rand Water Care Company (ERWAT) Research Chair in Water Management
Energy and Water Sector Education Training Authority (EWSETA)
Sustainable Livelihoods Foundation
Tshwane University of Technology
University of Johannesburg
Virtual Consulting Engineers

Africa

Namibia University of Science and Technology, Namibia
Makerere University, Uganda

International

CSIRO, Land and Water, Australia
Dept of Biochemistry and Biophysics, Mission Bay Campus, University of California, USA
Division of Infectious Diseases, Department of Medicine, Faculty of Medicine and Dentistry, University of Alberta, Canada
Fraunhofer-Gesellschaft zur Forderung der angewandten Forschung, Germany
Norwegian Handelens Miljøfond
Purdue University, United States of America
Research Councils UK-Global Challenges Research Fund
Swiss-African Research Cooperation
Ulster University, Northern Ireland
University of Bath, United Kingdom
Westerdijk Fungal Biodiversity Institute, Utrecht, The Netherlands

FUNDING

South Africa

Casidra
Cipla India
Cipla MedPro
Claude Leon Foundation
Department of Science and Innovation, South Africa
East Rand Water Care Association (ERWAT)
Energy and Water Sector Education and Training Authority (EWSETA)
FirstRand Foundation
Global Challenges Research Fund
National Research Foundation
NRF SARChI research chair for Biofuels
South African Biosystematics Initiative
South African National Energy Research Institute
Stellenbosch University
Technology Innovation Agency (TIA)
Water Research Commission
Western Cape Government, Environmental Affairs and Development Planning

International

European Commission Horizon 2020
Fraunhofer-Gesellschaft

STAFF MATTERS

During May 2019 Prof Steven N. Liss, an expert in environmental microbial ecology and Vice-President Research and Innovation from Ryerson University, Canada, was appointed for a period of three years as Extraordinary Professor in Microbiology at SU. During November 2019 Dr Lydia-Marie Joubert, an expert in modern microscopic methods at Stanford-SLAC cryo-EM Center, USA, was appointed for a period of three years as Extraordinary Associate Professor in Microbiology at SU.

STAFF LIST

Academic staff

Prof M Bloom
Prof A Botha (Departmental chair)
Prof LMT Dicks (Distinguished Professor)
Prof K Jacobs
Prof W Khan
Prof WH Van Zyl (Distinguished Professor; Biofuels Research Chair)
Dr H Volschenk
Dr T Jansen
Prof GM Wolfaardt (Director, Stellenbosch University Water Institute and ERWAT Chair in Water Research)

Extraordinary professors

Prof P Weimer
Prof S Liss
Prof LM Joubert

Emeritus Professor

Prof Doug Rawlings

Affiliated

Prof TE Cloete (vice-rector: research and innovation)

Support staff

J Daniels
LJ Daniels
J de Kock
M Gey van Pittius
M Stuurman
T van der Merwe
L van der Westhuizen
W Wentzel

Postdoctoral fellows and researchers

Dr Edward Archer
Dr Elanna Bester
Dr Kim Bester
Dr Marelize Botes
Mr Casper Brink
Dr Rose Cripwell
Dr Shelley Deane
Dr Maria Garcia
Dr Thando Ndlovu
Dr Shaunita Rose
Dr Wendy Stone
Ms Lisa Warburg

SOCIAL IMPACT

In 2019, the Kayamandi River Partnership, involving the SU Water Institute (SUWI) and the Stellenbosch Municipality, presented an initiative in collaboration with learners from Kayamandi, the Water Research Laboratory in the Department of Microbiology, and several external stakeholders to clean-up the Krom River in Stellenbosch.
Prof Wesaal Khan and her research team were invited to create awareness on the microbial quality of the river water and provide information on the potential health risks associated with using water from the Krom River.

Postgraduate students from the Department of Microbiology informed learners about the potential health risks associated with polluted water during an outreach initiative organised by the SU Water Institute. *Photo: Wiida Fourie-Basson*

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DEPARTMENT OF PHYSIOLOGICAL SCIENCES

RESEARCH INTERESTS

Cancer research
Cardio-metabolic research
Cardio-oncology research
Chemotherapeutic resistance in breast cancer and type 2 diabetes
Clinical haemorheology and coagulation research
Metabolic physiology and health
Multidisciplinary stress biology
Muscle physiology research
Neuro research

RESEARCH HIGHLIGHTS

Could this bacteria be the true cause of Parkinson's disease?

The research group of Prof E Pretorius discovered the bacterial protease RgpA from the mouth pathogen, *Porphyromonas gingivalis*, in the blood samples of patients with Parkinson's disease. This finding was published in *Frontiers in Aging Neuroscience*. Early in 2019, Prof SS Dominy's research group found the same protease in Alzheimer's disease brains, published in *Science Advances*. Both these findings were mentioned in *New Scientist* in the August 2019 edition with the title, "Have we found the true cause of diabetes, stroke and Alzheimer's?"

During the year this research group published 12 papers, two of which in *Nature Reviews Rheumatology* and one in a Cell journal, *Trends in Endocrinology and Metabolism*. In collaboration with Prof Anna-Mart Engelbrecht from the Department and Prof Willie Perold from the Faculty of Engineering, a start-up company with the name BioCODE technologies was founded. The aim of the company is to develop nanobiosensors for the early detection of inflammatory markers in blood samples in individuals with inflammatory conditions. At the time of submission the University Technology Fund (UTF) (SA SME FUND) intends to fund this endeavour and was in the process of finalising the approvals in order to execute the funding. – *Prof E Pretorius*

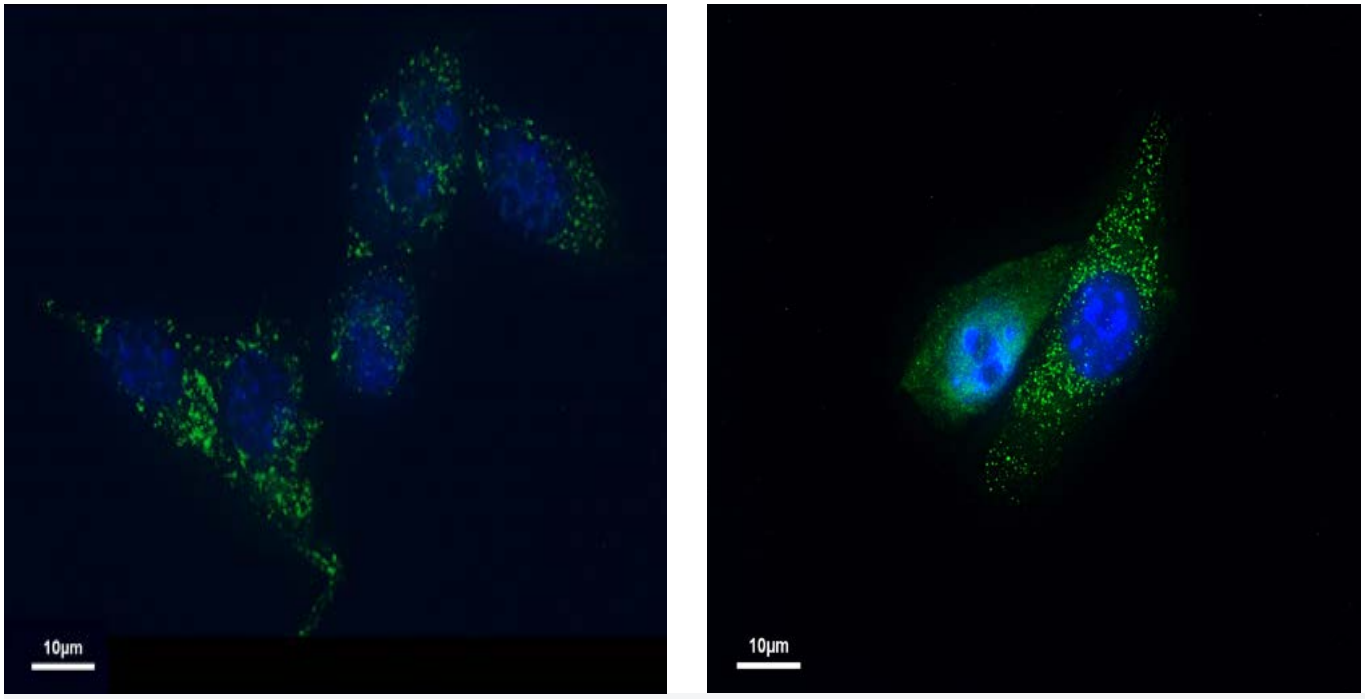
Role of autophagy in cell death highlighted

Key highlights in the neuro research group were publications that highlighted the role of autophagy in cell death, through driving a lethal autophagic flux, published inter alia in the journal *Cell Death and Differentiation*. Moreover, recommendations around in vivo autophagy flux measurements and how to move autophagy precision control into the clinic, have been published in the journal *Autophagy*. A patent has been filed on the measurement of autophagic flux, and an invited book chapter on brain autophagy in aging has been completed. On the method development front, postdoctoral fellow Dr André du Toit, and PhD student Jürgen Kriel spent three weeks at the Rutherford Appleton

Institute, London, learning the assembly of a light sheet system, with the aim to rebuild the system at the department. Finally, a workshop on high-end imaging 'Embracing Industry 4.0 Revolution – Bio-imaging Trends and Applications in Life Sciences' has been conducted in Mysure, India, together with Dr du Toit and Dr Theart (Electric/Electronic Engineering), which included the role of virtual reality in precision cell analysis. – *Prof B Loos*

NEW RESEARCH ON MICROENVIRONMENT OF CANCER TUMOURS

The research group of Prof AM Engelbrecht published ten research articles in 2019, which include the MSc work of Carla Fourie. She demonstrated for the first time that fibroblasts in the tumour microenvironment are influenced by chemotherapeutic treatment to secrete factors, which make cancer cells less susceptible to cell death. This work was published in the journal *Experimental Cell Research,* entitled "The paracrine effects of fibroblasts on Doxorubicin-treated breast cancer cells". Co-authors were Tanja Davis, Jurgen Kriel and Anna-Mart Engelbrecht. – *Prof A-M Engelbrecht*



Representative images of LC3 puncta quantification in E0771 breast cancer cells following fibroblast conditioned media (CM) and doxorubicin (DXR) treatment and autophagy inhibition. E0771 cells were seeded and treated with control CM and DXR for 24 hours and Bafilomycin (Baf) was added 4 hours prior to the staining protocol. *Images: Anna-Mart Engelbrecht*

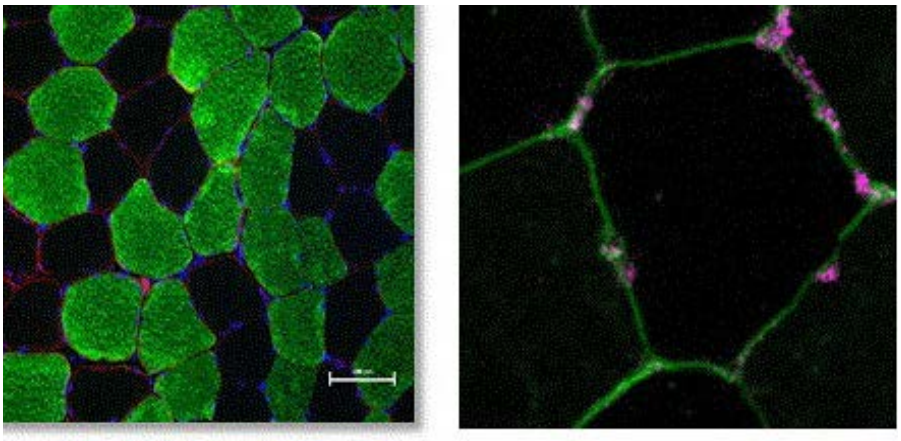
New Centre for cardio-metabolic research in Africa established

The Centre for Cardio-metabolic Research in Africa (CARMA) – with Prof Faadiel Essop appointed as its first Director – was formally approved by Stellenbosch University's Senate on 8 March 2019. The first year was characterised by several planning meetings that set the stage for the second year of operation. A successful mini-symposium was held with several presentations delivered by students and researchers from the Faculty of Medicine and Health Sciences and the Faculty of Science). – *Prof MF Essop*

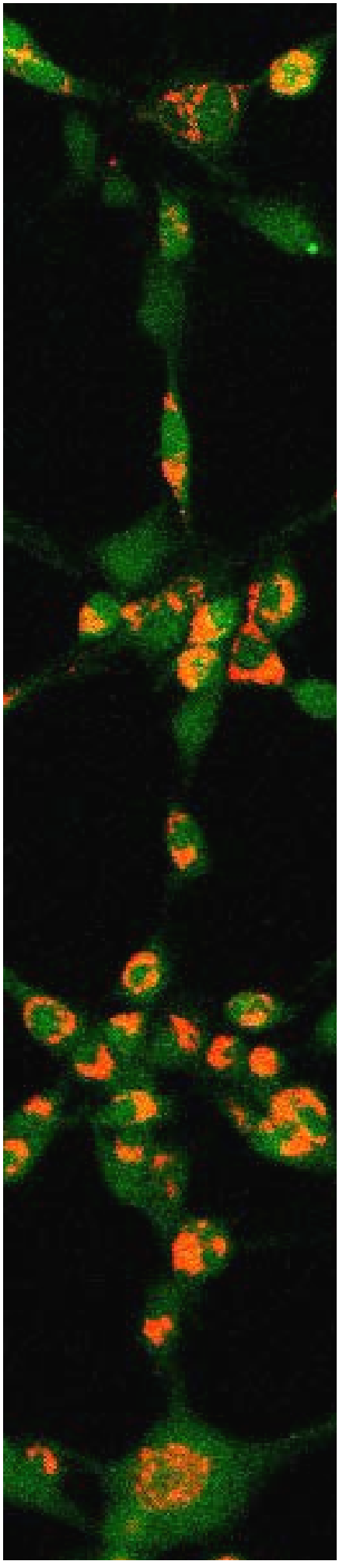
Postgraduate students and researchers from the Faculties of Science and Medicine and Health Sciences attended a mini-symposium as part of the activities of the newly-established Centre for Cardio-metabolic Research in Africa.

New research investigates impact of micro-damage to muscle tissue and blood flow

Prof Kathy Myburgh, holder of the SARChI research chair for Integrative Skeletal Muscle Physiology, Biology and Biotechnology, leads the Muscle Research Group in the Department. Muscle physiology is investigated in human or rodent tissues after interventions such as high intensity interval training (HIIT) or moderate muscle micro-damage. An MSc student proved that downhill HIIT first induced pain and microdamage, but ultimately resulted in increased cross-sectional area of Fast Twitch fibres. In contrast, uphill HIIT induced an increase in blood supply to thigh muscle via capillaries (see Figure below). Prof Myburgh was invited to present this work in a Symposium for the American Physiology Society at the Experimental Biology Meeting in the USA on 2 April. This new knowledge can be applied by competitive athletes in order to better design their training programmes. It is especially relevant for rehabilitation of muscle when it has gone through atrophy and loss of capillaries from disuse, which could occur e.g. whilst a limb is in plaster cast for bone repair, or after prolonged bedrest. – *Prof KH Myburgh*

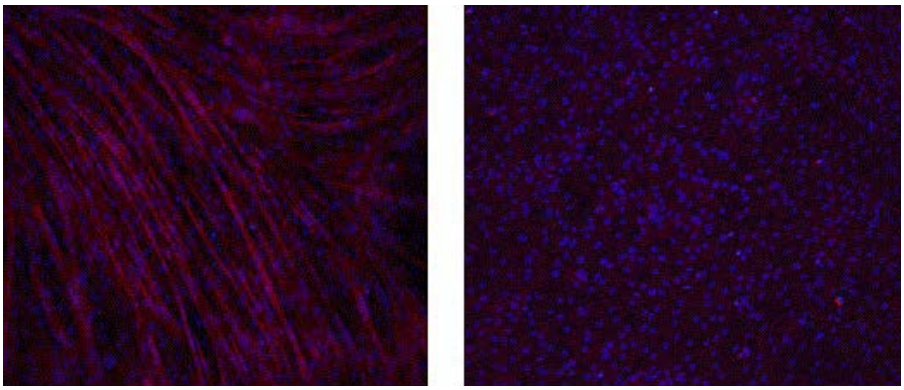


Human muscle biopsy sections. On the left, green fluorescent stain indicating larger fast twitch fibres and on the right, pink stain indicating blood capillaries bringing oxygen and nutrients to the fibre. *Images: Kathy Myburgh*



Role of the protein Kirrel in growth and repair of muscles

In the Biology and Biotechnology division of the muscle research group, a PhD student used genetic engineering techniques to knock out or overexpress a particular protein, called Kirrel. Kirrel is required for myoblasts to fuse to each other, which is part of the process of growth and hypertrophy and repair of muscles. The student was invited to present this work as an oral presentation in Slovenia in 2019 and as a poster at a Myogenesis Conference in Italy. The Myogenesis Conference is part of the Gordon Conference Series of specialist conferences which can only be attended by a maximum of 200 people. Only new unpublished work may be presented. The application of this work is for the use of myoblasts for cell therapy: fusion can be inhibited in order for primary myoblasts to proliferate more in bioreactors, whereas Kirrel could be usefully overexpressed when the myoblasts are delivered to repair muscle pathologies, so that they can more easily fuse with the damaged fibres. – *Prof KH Myburgh*



Differentiation of wild-type and genetically modified mouse skeletal myoblasts (C2C12s). The differentiation of wild-type C2C12 myoblasts results in the formation of elongated, multi-nucleated myofibers (A). The formation of these myofibers is completely inhibited in C2C12s in which the fusion protein, Kirrel1, is knocked-out using Crispr/Cas9 (B). Nuclei are stained blue and the structural protein actin stained red. *Images: K Myburgh*

RESEARCH ACTIVITIES

Prof A-M Engelbrecht was session chair at the 25th International Cell Death Society (ICDS) conference in New York in April 2019. She serves on the Governing Board and the Management Committee of the African Cancer Institute (ACI). She serves on the editorial boards of *Frontiers in Pharmacology* and the *International Journal of Biomedical Sciences*. She serves on the Senate Appointment Committee, the Faculty of Science Progamme Committee; Bioinformatics and Computational Biology Programme Committee, Biomedical Engineering Programme Committee and as the Programme Leader of the BSc Human Life Sciences Programme. She is also a member of the Science Café Stellenbosch organising committee.

During 2019 she visited China on two occasions as part of the thousand talents program sponsored by the Chinese government. One of her postdoctoral fellows, Dr Tanja Davis, attended the Fifth CRI-CIMT-EATI-AACR International Cancer Immunotherapy Conference which took place in Paris, France, from 25 to 28 September. The title of her poster presentation was "Serum amyloid A promotes inflammation-associated damage, macrophage infiltration and tumorigenesis in colitis-associated colon cancer".

Prof Faadiel Essop delivered several talks at a number of international meetings. He was an invited speaker at the sixth International Symposium on New Frontiers in Cardiovascular Research which took place from 1 to 4 April in Stellenbosch. The title of his lecture was "HIV and risk for cardiovascular diseases onset: role if immune activation".

He was invited symposium speaker at the Federation of European Physiological Societies and the Italian Physiological Society Congress on 10 to 13 September in Bologna, Turkey; as well as invited plenary speaker at the IUPS-BRICS Symposium on Stress, 23 September, St. Petersburg, Russia.

Prof Essop continued to act in roles regarding the following capacities: Vice-president of the African Association of Physiological Sciences; Board member of the General Assembly of the International Union of Physiological Sciences; and Chairperson of the Research Advisory Committee of the Heart and Stroke Foundation of South Africa. In adidtion, he continued as an editorial board member for the journals *PLOS ONE, American Journal of Physiology Heart, Physiology* and *Physiological Reports*.

Prof B Loos was part of a delegation to China, where innovative technologies were presented. He presented a paper at the 25th anniversary meeting of "Cell death through the ages" which took place in New York, USA, in June 2019, and was invited as a panel member at the Science Forum, Innovation Bridge, with the topic 'The brain and neurodegeneration'. He presented at the local microscopy conference of the Medical Society of South Africa (MSSA) and was invited to serve as editor for the journal *Autophagy*.

Prof KH Myburgh was an invited symposium speaker at the Experimental Biology Conference in Miami, USA. She was a keynote speaker at the Skeletal Muscle from Cell to Human symposia and workshop that took place in Slovenia. She was also an invited speaker at the Medical Research Council's Flagship Stem Cells Conference, in Pretoria. She furthermore attended the Physiology Society of Southern Africa's conference in East London, and hosted international visitors, Prof S Labeit and Dr C Witt from the University of Heidelberg in Mannheim, Germany.

Dr T Nell was host to Prof Sebastien Farnaud and Prof Derek Renshaw from the University of Coventry. Dr Nell is also a member of the Social and Behavioural Research Ethics Committee.

Prof E Pretorius visited China on three occasions in 2019. This was part of the thousand talents program of the Chinese government. In September she presented her research at the second G60 Sci-Tech Innovation Valley Talent Summit held in Zheijang, with the title "The bioCODE, nanobiosensor". Two postgraduate students in her group, Masimo Nunes and Martin Page, received NRF equipment-related travel funds to visit Prof Ursula Windberger from the Medical University of Vienna in Austria in order to analyse samples on a rheometer.

Dr B Sishi attended the Physiology Society of SA (PSSA) conference in East London, where she was elected as secretary/treasurer. She is a member of the executive committee of the South African Society for Cardiovascular Research (SASCAR).

ACADEMIC AFFAIRS

Dr T Nell is head of the Department's undergraduate modules, and course coordinator for F334 and F364, while **Dr B Sishi** is course co-ordinator for F314 and F344. In both cases the modules boasted with very good pass rates.

Prof A-M Engelbrecht introduced two new streams, namely Applied Medicinal Chemistry (Chemistry, Physiology, Patent Law) and Biomedical Mathematical Sciences (Mathematical Sciences, Physiology and Biomedical Engineering).

Prof C Smith delivered three Phd-graduates, namely Drs R Adams, Y Powrie and JG Visser.

Dr Ilze Mentoor graduated under supervision of **Dr T Nell**, and Dr K Gudagudi graduated under supervision of **Prof K Myburgh**

NRF-RATED RESEARCHERS		
Internationally acclaimed researchers	Prof KH Myburgh	Skeletal muscle physiology, biology and biotechnology
	Prof E Pretorius	Clinical haemorheology and coagulation research
Established researchers	Prof MF Essop	Health sciences
	Prof C Smith	physiology (basic sciences)
	Prof A-M Engelbrecht	Tumour micro-environment and chemotherapy resistance
Y-I	Prof B Loos	Autophagy and cell death

FUNDING

South Africa

Brenn-o-kem
National Research Foundation (NRF)
Cancer Association of South Africa (CANSA)
Stellenbosch University Fund for Innovation and Research into Learning and Teaching (FIRLT)
NRF Competitive Programme for Rated Researchers (CPRR)
NRF SA Research Chair grant

International

European Union Rise grant collaborator

AWARDS TO STAFF AND STUDENTS

Prof E Pretorius was awarded runner-up in the SA Women in Science: Distinguished Women Scientist category.

Prof F Essop successfully completed a one-year part-time course (NQF Level 8 level) on the Scholarship of Educational Leadership (SOEL) at Stellenbosch University and was also a collaborator on a successful Erasmus Plus Mobility grant with six other countries that allows for staff and student exchanges between participating universities. Prof Essop's MSc student, Miss Nina Truter, received the Johnny van der Walt prize for the best poster at the annual Physiology Society of Southern African (PSSA) congress.

Prof KH Myburgh's postgraduate students were very busy during 2019. Jason Lovett received an European Molecular Biology Labs Travel Award, Rhys McColl was invited to attend the Gordon Conference in Myogenesis in Italy and made an oral presentation at the Erasmus Symposium/Workshops in Slovenia; Kiran Gudagudi co-chaired a session in the Tissue Engineering Regenerative Medicine International Society (TERMIS) conference in Greece, and was invited to present at the MRC Flagship Stem Cells Conference in Pretoria. Last, but not least, Kiara Boodhoo received the Most Innovative Method Prize during the PSSA's Wyndham Competition.

STAFF MATTERS

Prof Carine Smith was promoted to full professor, and **Dr Chantelle Venter** was appointed as Technical Officer.

Staff list

Academic

Prof A-M Engelbrecht
Prof MF Essop
Prof B Loos
Prof K Myburgh
Dr T Nell
Prof E Pretorius (head of department)
Dr B Sishi
Prof C Smith
Dr JADW Strauss

Technical and Support Staff

Mr J Isaacs (assistant)
Dr D Joseph
Dr A Krygsman
Ms GA Simon (admin)
Dr C Venter

Extraordinary professors

Prof Douglas Kell
Prof Ismail Laher

Research fellow

Dr Graham Ellis

Postdoctoral Fellows

Dr T Davis
Dr A du Toit
Dr T Maduna
Dr K Martin
Dr E Teer
Dr G van Niekerk
Dr DP van Staden
Dr N Woudberg

SOCIAL IMPACT

Life Science practicals for learners from Lückhoff Secondary School

Staff in the Department of Physiological Sciences combined forces with the Department of Food Sciences in the Faculty of AgriSciences to provide Life Science practicals for Grade 10-12 learners at Lückhoff Secondary School in Idas Valley, Stellenbosch.

The primary goal of the initiative is to provide resource and infrastructure support; aid teachers in conceptualising, developing and implementing practical sessions in line with the prescribed syllabus; and facilitate the presentation and demonstration of practical work to enhance science learning and skills development. The curriculum requires one practical to be performed and assessed per term for the first three terms of the calendar year. Each session therefor aims to address a specific prescribed theme that has been covered in theory lessons during the term, as required for the curriculum, and in consultation with the teachers. – *Drs T Nell, B Sishi (Physiological Sciences) and D Joseph and Veronique Human (Food Sciences)*

Outreach activities

As part of the workshop presented in India, Prof Ben Loos conducted an outreach to a local school for financially vulnerable children, with a talk on science, innovation and virtual reality.

As part of the Cancer Research Group's (CRG) outreach initiative, MSc student Charné Prangley did weekly talks on cancer and prevention on Maties FM. The CRG also hosts an active Instagram page # SUCRs for Cancer.

Postgraduate students in the Centre for Cardio-metabolic Research in Africa (CARMA) arranged a successful campaign on main campus to promote heart health – coinciding with World Heart Day in September 2019.

CONTACT DETAILS

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DEPARTMENT OF PHYSICS

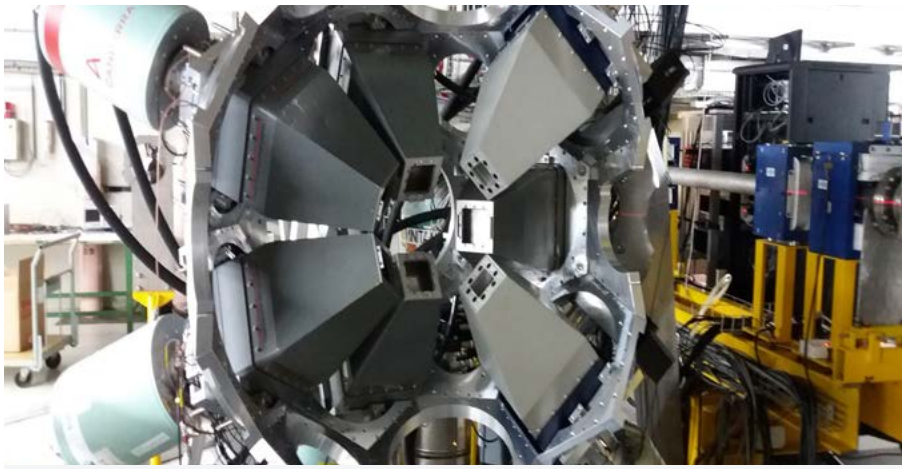
RESEARCH INTERESTS

Ultrafast laser science
Spectroscopy and laser diagnostics
Laser development
Trapped ion quantum control
Biophotonics and imaging
Additive manufacturing, X-ray imaging and biomimicry
Solitons in field theory
Quantum phase transitions and exceptional points
Multiparty correlations and Bayesian physics
Condensed matter physics
Soft condensed matter and biological physics
Nuclear physics

RESEARCH HIGHLIGHTS

New milestones for the GAMKA consortium

The Strategic Research Equipment Programme, managed by the National Research Foundation, granted R35 million in 2018 for a drastic improvement of the experimental equipment for research into the Structure of Atomic Nuclei and Nuclear Astrophysics at iThemba LABS. The application was a joint action of Stellenbosch University, University of the Western Cape, University of the Witwatersrand, University of Zululand and iThemba LABS. A new detector arrangement in the form of an icosahedron shape, better known as a soccer ball, was built to host up to 30 radiation detectors simultaneously together with a vacuum chamber optimised for low gamma-ray absorption. GAMKA (the Gamma Ray Spectrometer for Knowledge in Africa) is supported by the National Research Foundation of South Africa and by contributions from iThemba LABS, Stellenbosch University, University of the Western Cape, University of the Witwatersrand, and the University of Zululand. – *Prof Paul Papka*



The right side of the new detector arrangement is in the form of an icosahedron shape, better known as a soccer ball. *Photo: Paul Papka*

Prof Mark Tame new holder of the SARChI chair in Photonics, Ultrafast and Ultra-intense Laser Science

The SARChI Chair restarted with the arrival of Prof Mark Tame, previously from University of KwaZulu Natal-Westville, at the end of 2018. In 2019 he set up a new Quantum Nanophotonics lab, so that there are now three main experimental research areas being actively pursued by the group, namely Solid-state photonics for quantum communication networks; Photonic quantum sensing for biochemistry applications; and Photonic quantum processors for quantum computing.

Collaborations in 2019 involved joint work with the group of Prof Xifeng Ren at the University of Science and Technology of China on a new device for generating entanglement on a quantum photonic chip, as well as a book chapter on quantum sensing with Prof Carsten Rockstuhl and Dr Chang Lee at Karlsruhe Institute of Technology in Germany.

The activities of the Chair in 2019 included the organisation of the Quantum Africa 5 conference in Stellenbosch, for which the Chair was a co-organiser. This was a conference of about 100 researchers from all over Africa working in the field of quantum technologies. The conference was well attended and provided an opportunity for discussions, collaborations and interactions between quantum researchers from the African continent. Prof Tame gave an invited talk at the SPIE conference in San Diego (USA) where he presented a paper on photonic quantum sensing. He presented seminars at Osaka University and the Okinawa Institute of Science and Technology (OIST) in Japan, as well as a few lectures at the latter institution.

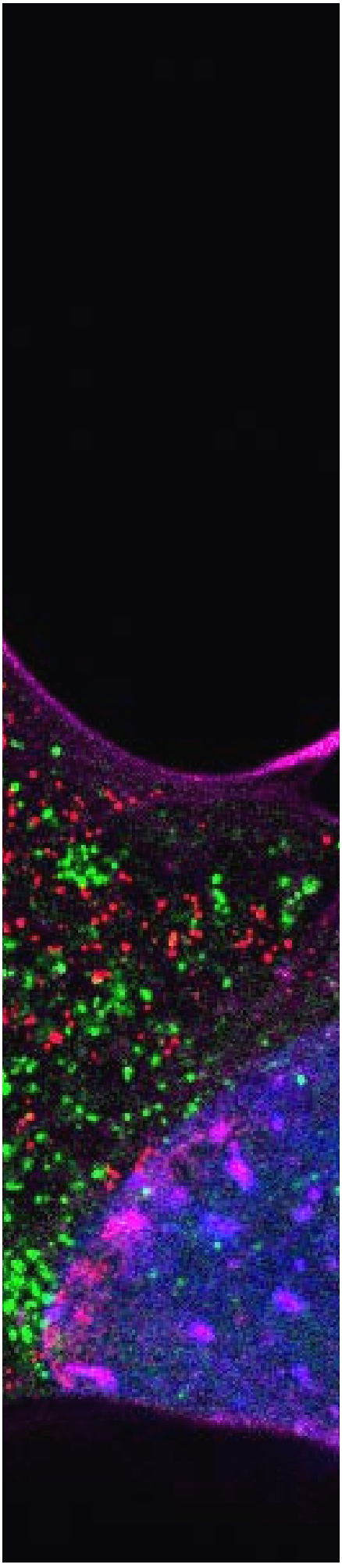
Outreach activities of the Chair in 2019 involved presenting at the International Day of Light event at Stellenbosch University and at an Optical Society of America Student Chapter Evening. The Chair was involved in reviewing activities, including as an Editorial Board member for the international journal *IOP Journal of Optics* and refereeing for various European funding agencies. – *Prof Mark Tame*

New laser and spectroscopy development laboratory established

Dr Pieter Neethling and Dr Gurthwin Bosman have initiated a new laser and spectroscopy development laboratory. The laboratory is being refurbished and equipped with state of the art optics and opto-mechanical components in order to create a space where innovative ideas can be tested and once-off experiments be performed. The capabilities of the laboratory will be built up over time, allowing it to serve as a technology incubation space, teaching environment and a concept test platform. – *Dr Pieter Neethling*

Using lasers to detect drones

A pilot study using lasers for the remote detection and identification of small unmanned aerial vehicles (UAV's), more commonly known as drones, was conducted together with the Institute of Maritime Technology. Drones impinging on the airspace of commercial airports have in recent years become an ever increasing problem, and the accurate detection and identification of these drones is the first step in addressing this problem. The successful pilot study showed that the same technique and technology, previously used to detect and identify flying insects, can be adapted and repurposed to detect drones. A follow up study is planned for completion in 2021, with the aim of extending the range of detection. – *Dr Pieter Neethling*



RESEARCH ACTIVITIES

Mr Gary Andrews visited the University of the Free State in November 2019 to conduct research into the stability properties of orbits in the Kerr metric. He also received a FIRLT grant for the production of video lectures in physics and annotated tutorial memorandums for the flipped classroom. Due to the Covid-19 pandemic, the project will carry over to 2021. Mr Andrews is also in the process of writing notes for the Physics 176 module, to be made available in three languages: isiXhosa, Afrikaans and English.

Dr Gurthwin Bosman co-organised the African Laser Centre's Laser Imaging and Spectroscopy workshop which took place from 25-27 November 2019 at Stellenbosch, as well as the 12th African Laser Centre Student Workshop, 20-23 November 2019.

Prof Hans Eggers and MSc students Scott Cameron and Riyaadh Jamodien attended the 2019 Maxent Conference at the Max Planck Institute for Plasma Physics in Garching, Germany. Scott presented a poster and won second prize based on an open international competition as well as some prize money. As a result, his work was accepted for publication in the conference proceedings and is awaiting publication. Following that submission, he was invited to submit a full-length journal article to the journal *Entropy* which both extends and improves on the methods developed for his poster presentation. Scott's work, entitled "Stochastic Gradient Annealed Importance Sampling for Efficient Online Marginal Likelihood Estimation", combines several existing Monte Carlo methods to effect calculation of the crucial Bayesian "Evidence" (Marginal Likelihood) and thereby improves on state-of-the-art methods to allow continual evidence updating for streamed data. Maxent 2019 was followed by a research visit to Dr Michiel de Kock in Hamburg.

Dr Hannes Kriel is part of the AIMS (African Institute for Mathematical Science) executive team.

Prof Kristian Müller-Nedebock collaborated with Prof Tony Parker, Prof Stan Botchway and Dr Alessia Candeo on research on filaments in confined geometries such as cells and small pores at the Central Laser Facility of the Rutherford Appleton Laboratory, UK, in January 2019. He was also on a research visit to Dr Christian Rohwer at the Max Planck Institute for Intelligent Systems Stuttgart, Germany (October 2019). Dr Rhoda Hawkins from the University of Sheffield in the United Kingdom visited the department in August 2019, to perform research in his group. Prof Müller-Nedebock also collaborated with members of the Max Planck Institute for Intelligent Systems in, Stuttgart, Germany, the Rutherford Appleton Laboratory in the United Kingdom, the Department of Physics and Astronomy at the University of Sheffield, United Kingdom, and the Department of Mathematics and Applied Mathematics at the University of Bristol in the United Kingdom.

Dr Pieter Neethling attended the Cleo/Europe-EQUC 2019 conference in Munich, Germany, where he presented a poster on THz ellipsometry work. During this trip to Europe, he also visited the Rutherford Appleton Laboratories in the UK to meet with his collaborators, Prof Tony Parker and Dr Andy Ward. He was co-organiser of the African Laser Centre Laser Imaging and Spectroscopy workshop which took place from 25-27 November 2019 at Stellenbosch, as well as the 12th African Laser Centre Student Workshop from 20-23 November 2019. Dr Jan Rothhardt from the Helmholtz Institute in Jena, German, visited the group in December 2019 on a short research visit.

Prof Erich Rohwer visited Bern for six months to re-establish collaboration with Proff Thomas Feurer, Alex Heidt and Dr Dirk Spangenberg and develop an application for the National Laser Center (NLC) rental pool support for a joint project which links past

research to the future. He visited the Rutherford Appleton Laboratory (RAL) at Harwell, Oxforshire and met with Prof Tony Parker and Dr Andy Ward about collaboration with regard to PhD-student Anneke Erasmus' research. Prof Rohwer visited the University of Durham and established links with Prof Robert Pal relating to microscopy. He also visited Prof Reiner Heintzmann and Ms Dina Miora, a DAAD sponsored joint PhD student, at the Abbe Center for Photonics at the Friedrich Schiller University of Jena, as well as Prof Herbert Stafast from the Leibnitz Institute of Photonic Technology (IPHT) and Dr Jan Rothhardt of the Abbe Center of Photonics at the Friedrich Schiller University, Jena. Prof Rohwer was an invited speaker at the OPTIcs and Applications to Sustainable Development (OPTISUD) conference in Tunisia, an Optical Society of America (OSA) and the International Society for Optical Engineering (SPIE) workshop on sustainable optics. He attend the Cleo/Europe-EQUC 2019 conference in Munich, Germany where the research group presented three papers.

Prof Rohwer was co-organiser of the African Laser Centre's Laser Imaging and Spectroscopy workshop 2019, 25-27 November 2019, Stellenbosch as well as the 12th African Laser Centre Student Workshop, 20-23 November 2019. The Newton Fund supported a delegation from the Rutherford Appleton Laboratory in the UK to the ALC workshop. The delegation consisted of Prof Niel Hunt from the University of York, Dr Alessia Candeo from the Rutherford Appleton Laboratory and Prof Robert Pal from the Durham University. Other visitors were Prof Jonathan Leach from Herriott Watt University with Prof Andrew Forbes from the University of the Witwatersrand. The Federal Ministry of Education and Research (BMBF) in Germany also funded a delegation, consisting of Prof Rudolph Steiner from the University of Ulm, Cornelia Denz from the University of Meunster, Herbert Sneckenburger from the University of Aalen, Reiner Heintzmann (FSU Jena), Uli Lemmer from the Kalsrule Institute of Technology and Karl Stock from the University of Ulm.

The OSA/SPIE student chapter of the Laser Research Institute arranged a research visit sponsored by OSA by Dr Jan Rothhardt from the Abbe Center of Photonics in November.

The donation of frequency comb laser by the National Metrology Institute of South Africa (NMISA) during 2019 added significantly to the research infrastructure of the LRI. At the 2019 Workshop on Quantum Geometry, Field Theory and Gravity in Corfu in September 2019 **Prof Frikkie Scholtz** presented a paper titled "Classical Dynamics on Fuzzy Space".

At the American Association for Physics Teachers (AAPT) and Physics Education Research Conference (PERC) 2019 conference in the USA **Dr Philip Southey** presented an oral presentation and poster on the "Ratio Table: a tool for understanding ratios".

Dr Christine Steenkamp presented at the PLATAN 2019 conference in May in Germany. This was an international conference merger of the Poznan Meeting on Lasers and Trapping Devices in Atomic Nuclei Research and the International Conference on Laser Probing. Her presentation was about the collaborative project with iThemba LABS, KU Leuven (KUL) and the O.P. Jindal Global University (JGU) in India. She has continued collaborations with iThemba LABS, KUL, Johannes Gutenberg University (JGU) in Germany, the Isotope Mass Separator On-Line Facility (ISOLDE) at the European Organisation for Nuclear Research (CERN), University of Oslo, Norwegian Medical Cyclotron Centre, SaPhotonica (industrial collaborator in South Africa). Prof Thomas Cocolios from KU Leuven visited her research group during January and February 2019 to work on the isotope beam production project.

One of Dr Steenkamp's PhD students, Frikkie Waso, participated in an experiment on the hyperfine structure of Indium isotopes at ISOLDE CERN, with funding from the SA-CERN Consortium. He is listed as co-author on a paper that has been submitted for publication.

Another PhD-student, André de Bruyn, spent a six-month research period with collaborators at the University of Oslo. Dr Steenkamp was the director of the LRI until early 2020.

Prof Hermann Uys was organiser of the Quantum Africa 5 conference at Stellenbosch on 2-6 September. Quantum Africa 5 is the fifth in a series of successful conferences bringing the best of international quantum research to Africa, while striving for pan-African participation. The speakers were Dr Heike Riel from IBM, Prof Gerald Gabrielse from Harvard University, Prof Sonja Franke-Arnold from the University of Glasgow, Prof. Tracy Northup from Universtität Innsbruck, Prof Mourad Telmini from the University of Tunis El Manar, Prof Jason Petta from Princeton University, Prof James Thompson from the Joint Institute for Laboratory Astrophysics (JILA) at the University of Colorado Boulder and the National Institute of Standards and Technology (NIST), Dr Bienvenu Ndagano from the University of Glasgow, Dr Yingwen Zhang from the National Research Council Canada, Dr Obinna Abah from Queen's University of Belfast, Dr Ryan Sweke from the Freie Universität Berlin, Prof Barry Sanders from the University of Calgary, Prof Malik Maaza from iThemba LABS and the University of South Africa (UNISA), Prof Luis Sanchez-Soto from the Max Planck Institut fur die Physik des Lichts. The conference was sponsered by the NRF/DSI SARChi Chair in Quantum Information Processing, African Laser Centre, the Optical Society, PicoQuant, European Physical Society, Nkosi Innovations, CSIR/SU Research Chair in Quantum, Optical and Atomic Physics, Wirsam Scientific International Centre for Theoretical Physics, NT-MDT Spectrum Instruments.

Participants in the Quantum Africa 5 conference held at Stellenbosch in September 2019.

Prof Herbert Weigel presented a plenary contribution on a theoretical analysis of properties of particular subatomic particles at the international Workshop on Electroweak Processes of Hadrons in Bled, Slovenia, in July 2019.

Prof Fedor Simkovic of the Comenius University in Bratislava in Slovakia visited **Prof Shaun Wyngaardt** to collaborate on the establishment of an underground research facility in the Huguenot tunnel.

ACADEMIC AFFAIRS

Prof Hermann Uys has resigned to take up a position in the USA. Dr Christine Steenkamp takes over his responsibilities in research and teaching. There were 7 honours, 4 MSc and 11 PhD students that graduated during the 2019 academic year

NRF-rated researchers		
Leading international researcher	Prof Dieter Heiss	Physical effects and significance of spectral singularities
Internationally acclaimed researchers	Prof Anthony Cowley	Mechanism of proton-induced pre-equilibrium nuclear reactions, alpha-particle clusters in atomic nuclei and light-ion transfer reactions
	Prof Herbert Weigel	Quantum field theories emphasising on many different scenarios in which standard perturbative treatments cannot be applied. This comprises field configurations with localised energy densities, known as solitons or solitary waves.
	Prof Frederik Scholtz	Non-commutative quantum mechanics and quantum field theory
	Prof Michael Kastner	Quantum many-body physics; geometric and topological aspects of (quantum) phase transitions; magnetism and spin systems; quantum statistical physics applied to atomic physics (as it is of relevance for atom- or ion-trap-based quantum simulators of many-body systems)
Established researchers	Prof Erich Rohwer	Laser development, laser techniques and applications, laser spectroscopy and microscopy
	Prof Hermann Uys	Closed loop quantum control and quantum simulation using trapped ions.
	Prof Hans Eggers	Bayesian analysis in physics, data analysis, experimental high energy physics
	Prof Paul Papka	Clustering in nuclei is observed for a wide range of masses but particularly well in light nuclei
	Prof Brandon van der Ventel	Description of nuclear scattering reactions using a relativistic formalism; mathematical description of biological systems; technology in education
	Prof Richard Newman	Radionuclide metrology, environmental radioactivity, dosimetry, radiation transport modelling, radiation safety, elemental analysis, physics education
	Dr Christine Steenkamp	Laser spectroscopy of atoms and molecules, nonlinear optics, laser sources and laser spectroscopy in the vacuum ultraviolet, surface second harmonic generation, laser cooling of atoms and ions
	Dr JJ van Zyl	The study of the reaction mechanisms governing the emission of light alpha and He-3 clusters from the interactions of medium energy protons; alpha-particle clustering in nuclei such as Ne-20 by means of an array of detectors at iThemba LABS
	Prof Shaun Wyngaardt	Theoretical investigation of clustering phenomenon in nuclear matter; relativistic formulation of spin polarized proton induced nuclear reactions; development of a low level underground radiation facility in the Huguenot tunnel
Promising young researchers	Dr Hannes Kriel	Theoretical investigation of clustering phenomenon in nuclear matter; relativistic formulation of spin polarized proton induced nuclear reactions; development of a low level underground radiation facility in the Huguenot tunnel
	Dr Pieter Neethling	Using linear and nonlinear spectroscopic techniques to address problems in solid state physics, biochemistry and chemistry

FUNDING

South Africa

ARMSCOR – Virtual Defence Engagement Programme and Laser Defence Research Project (DESUP)
CSIR African Laser Centre
CSIR National Laser Centre's Rental Pool programme
CSIR Photonics Initiative of South Africa (PISA)
CSIR/SU Research Chair in Quantum, Optical and Atomic Physics
National Research Foundation (NRF)
Nkosi Innovations
NRF SA-China bilateral collaboration funding
NRF unrated researchers funding
NRF/DST SARChi Chair in Quantum Information Processing
SA-CERN Consortium
SA-JINR travel grant
South African Institute for Physics (SAIP) under the Women in Physics in SA (WiPiSA) project

International funding

United States of America

Optical Society of America (OSA)

Europe

European Physical Society
DAAD scholarships in Germany
Federal Ministry of Education and Research (BMBF), Germany
Newton Fund, Rutherford Appleton Laboratory
NT-MDT Spectrum Instruments for conference contributions
PicoQuant
Wirsam Scientific International Centre for Theoretical Physics

AWARDS TO STAFF AND STUDENTS

Frikkie Waso received the John Todd Morrison medal for the best MSc student in Physics. Jessica Craven received the Meiring Naudé prize for the best Honours student in Physics. Theoretical physics student, JC Louw, was amongst 20 top South African scientists to attend the 69th Lindau Nobel Laureate Meeting from 30 June to 5 July 2019 in Lindau, Germany.

STAFF MATTERS

Prof Hermann Uys, holder of the CSIR/SU research chair in Quantum, Optical and Atomic Physics, resigned to take up a position in the private sector in the USA. Two of the department's long-time administrators, Mrs Elsabé Bosch and Mrs Colleen April, retired in January 2020.

STAFF LIST

Academic

Mr Gary Andrews
Dr Gurthwin Bosman
Dr Daphney Bucher
Prof Anton du Plessis
Prof Hans Eggers
Prof Michael Kastner
Dr Hannes Kriel
Prof Kristian Müller-Nedebock
Dr Pieter Neethling
Prof Richard Newman
Prof Paul Papka
Prof Erich Rohwer
Prof Frikkie Scholtz
Dr Philip Southey
Dr Christine Steenkamp
Prof Mark Tame
Prof Hermann Uys
Prof Brandon van der Ventel
Dr JJ van Zyl
Prof Herbert Weigel
Prof Shaun Wyngaardt

Extraordinary Professors

Dr Faicel Azaïez
Prof Andrew Forbes
Prof Dieter Heiss
Dr Pieter Kotze
Dr Noel Mkhaza
Prof Jie Meng
Prof Tony Parker
Dr Einar Rolander
Prof Herbert Stafast

Professors Emeritus

Prof Piet Walters
Prof PR de Kock
Prof Anthony Cowley
Prof Hubertus von Bergmann

Support staff

Ms Colleen April
Ms Elsabé Bosch
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Mr Eben Shields

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Dr Wilfrid Ndebeka
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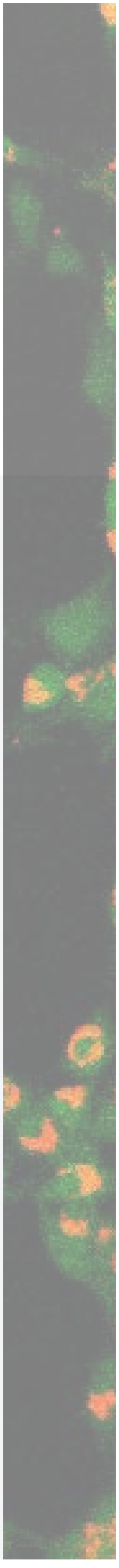
Dr OO Olaoye
Dr Dirk Spangenberg



SOCIAL IMPACT

The Optical Society of America funded the *International Day of Light on 16 May 2019* under the leadership of the Student Chapter. The theme was "The Experimentalist's Toolbox: Reason behind the Research".

The Physics Open Day on 15 August started with a welcoming and introduction by Prof K.K. Müller-Nedebock, head of the department. This was followed with a talk by Prof R.T. Newman titled "Matters of life and death: Some perspectives considering how radiation interacts with matter", as well as a number of physics demonstrations. At the end of the talk visitors were invited to attend theory and nuclear talks and visit the laser and radiation labs accompanied by postgraduate students.

The **Women in Physics event** on 21 August 2019 was organised by the Department of Physics Postgraduate Committee, and funded by the South African Institute of Physics (SAIP) under the Women in Physics in South Africa (WiPiSA) project. Dr Rhoda Hawkins from the University of Sheffield in the UK was the guest speaker.

The Department of Physics postgraduate students embarked on the annual road trip during the September recess to various schools in the West Coast, primarily situated along the N7. The route stretched as far as Lutzville and included a branching visit to Vredenburg. The aim of the trip was to expose high school learners to exciting physical phenomena via various demonstrations. Each demonstration was accompanied by a theoretical explanation and learners were encouraged to ask questions about the underlying physics. We also used the opportunity to inform learners about the opportunities available for further studies in physics at Stellenbosch University. This year, the recruitment officer for the Faculty of Science, Nonsikelelo Sackey, accompanied us to encourage students to pursue careers in science, placing an emphasis on the importance of Mathematics and Physical Sciences as high school subject. The group reached 301 students from seven schools. The road trip was funded by OSA, NITheP and the Department of Physics.

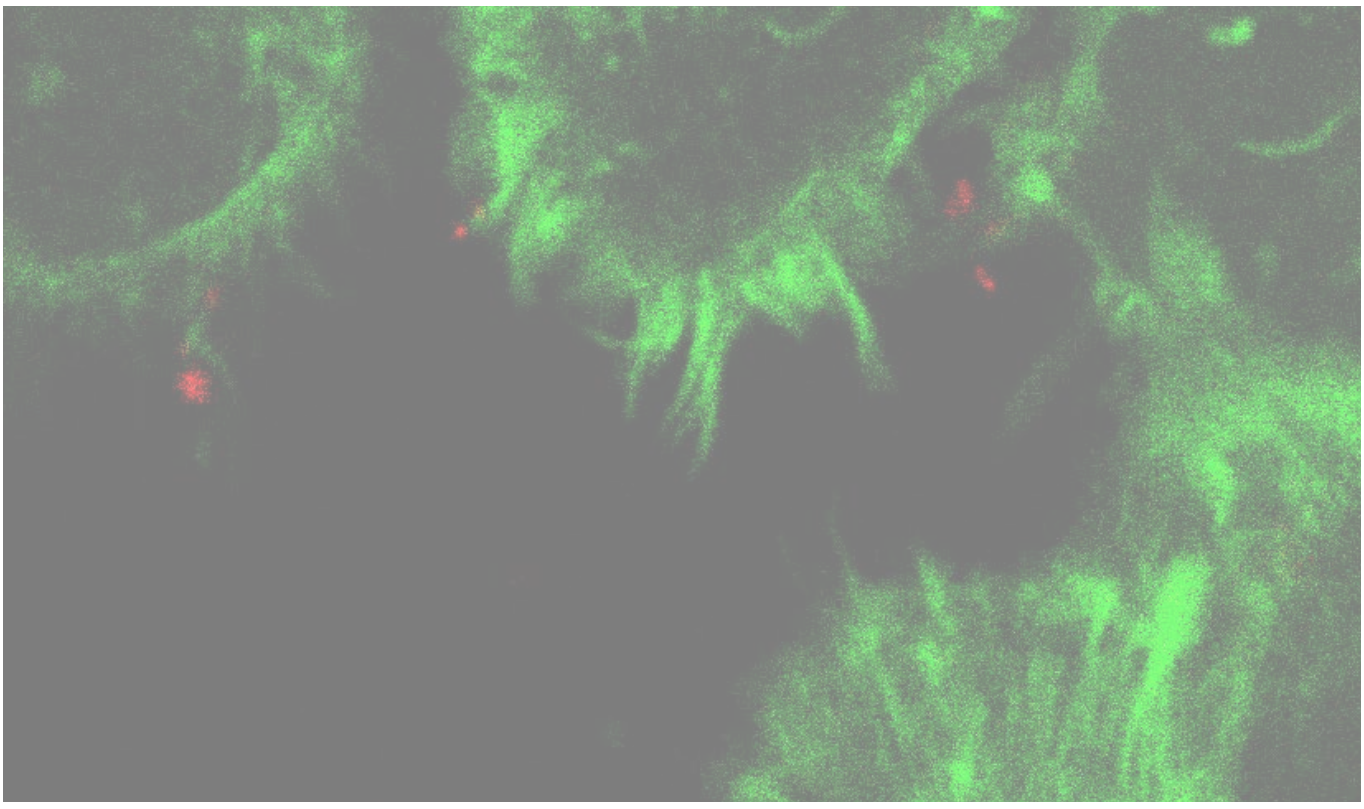
The department, together with the Departments of Physiological Sciences and Chemistry and Polymer Science, hosted a Nobel lecture evening on 22 October 2019, where the research behind the Nobel prizes in these three disciplines was explained in simple terms to an audience of 105 staff members, students and the general public.

On 23 October the postgraduate students helped Dr Gillian Arendse with an outreach initiative when 25 Grade 10 leaners from Delft Tech visited the Physics building. On Tuesday 29 October learners from Bridge House High School visited the campus for outreach activities and the post graduate students did some demonstrations.

The African Laser Centre Laser Imaging and Spectroscopy Workshop 2019 from 25-27 November 2019 at Stellenbosch was attended by 56 delegates and hosted by the Laser Reseach Institute. The workshop provided training for students in a range of fields in bio photonics with focus on laser tissue interaction and laser-based imaging techniques. The training was presented by international experts from Germany, Switzerland, the United Kingdom and South Africa. The workshop brought together students studying laser physics, as well as researchers in the fields of medicine, physiology, biology, chemistry and physics.

Postgraduate students and staff who attended the ALC workshop in November 2019.

The 12th African Laser Centre Student Workshop, which took place from 20-23 November 2019, was hosted by the LRI and attended by 58 delegates. This student workshop series is intended to benefit students associated with ALC projects to report back on their research during the past year. The workshop program is designed to facilitate student presentations by ALC bursary holding students and students coupled to ALC-funded projects and interaction with supervisors and project leaders.



The ALC organising committee included Dr Pieter Neethling, Prof Erich Rohwer, Dr Gurthwin Bosman, together with international guest speakers dr Alessia Candeo from Central Laser Facility, Science and Technology Facilities Council (STFC), Rutherford Appleton Laboratory, Prof Robert Pal from Durham University, and Prof Neil Hunt from York University.

Dr JJ van Zyl once again showed the Grade R learners from the Vineyard Pre-primary School in Somerset West a short astronomy show. The show involves an interactive planetarium image of the night sky full of star constellations, a fictional journey to the Moon and a visit to the planets, nebulae and other interesting celestial bodies.

The Department of Physics hosted a group of 30 Grade R learners from Die Wingerd Pre-Primary School on 6 November 2019. Dr JJ van Zyl demonstrated some physics phenomena such as static electricity, atmospheric pressure and liquid nitrogen. After refreshments on the grass in front of the Perold building, the learners built their own electric car with a little help from their teacher and parents. The morning ended with a turbulent laser obstacle course.

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LIST OF PUBLICATIONS 2019

DEPARTMENT OF BIOCHEMISTRY

Journal Articles (subsidised)

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Du Toit A. *Measuring and Modelling Autophagic Flux*. PhD, 2019. 232 pp. Promotor: Loos B. Co-promotor: Hofmeyr JS.

Jana C. *Synthesis, profiling and mode of action studies of PanSulfAms as inhibitors of coenzyme A biosynthesis and utilization*. PhD, 2019. 182 pp. Promotor: Strauss E. Co-promotor: De Villiers M.

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Horn S. *A Comparative Analysis of Within-host Models of Malaria Infection with Immune Response*. MSc, 2019. 121 pp. Promotor: Van Niekerk DD. Co-promotor: Snoep JL.

Mamhende PGM. *Investigation of the antifungal activity of tryptophan-rich cyclic peptides*. MSc, 2019. 162 pp. Promotor: Rautenbach M.

Muiyser SM. *The role of PFK in the oscillatory yeast strain x2180*. MSc, 2019. 93 pp. Promotor: Van Niekerk DD. Co-promotor: Snoep JL.

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DEPARTMENT OF BOTANY AND ZOOLOGY

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