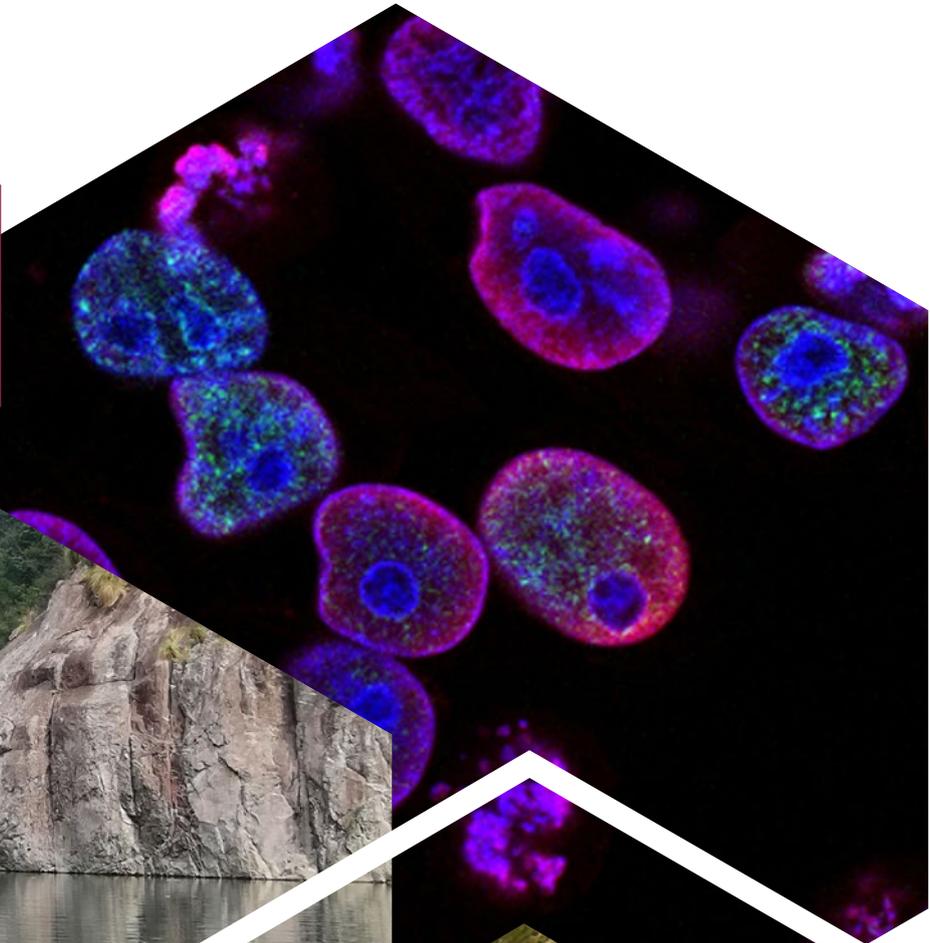




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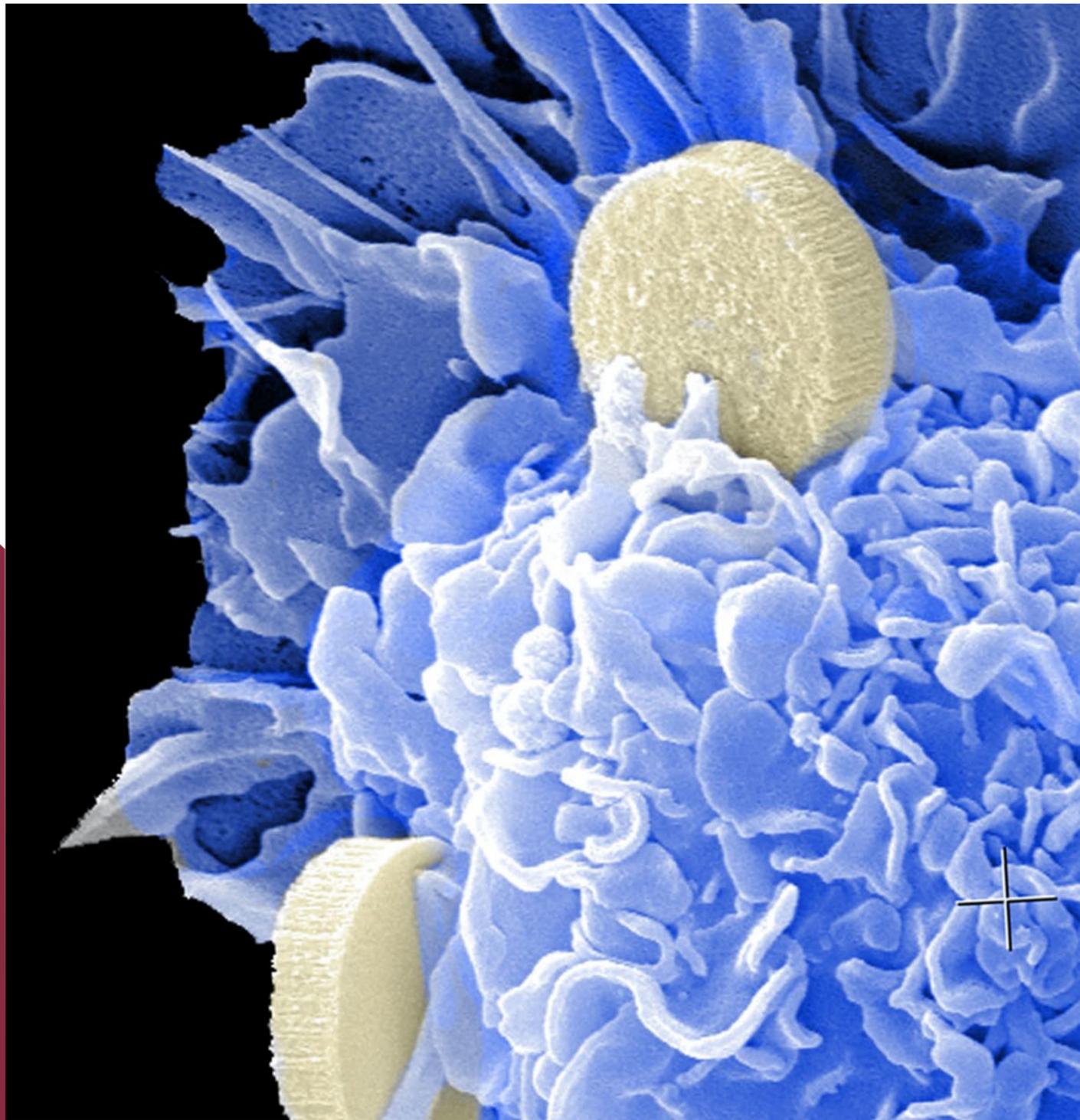


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# FACULTY OF SCIENCE

Stellenbosch University

20  
20



2 From the Dean's office

4 Teaching and Learning

10 Department of Biochemistry

16 Department of Botany and Zoology

26 Department of Chemistry and Polymer Science

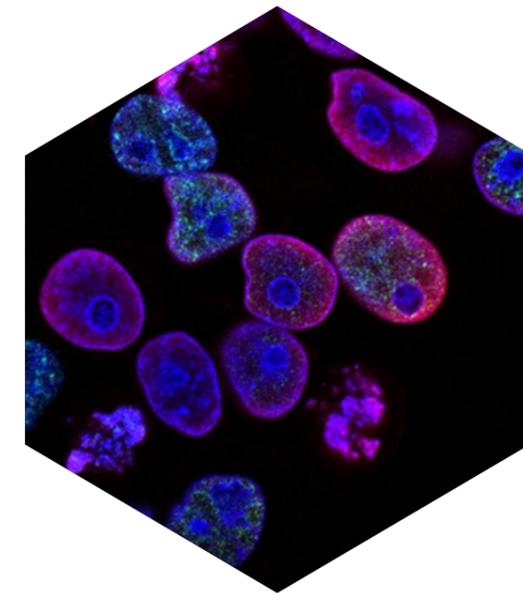
33 Department of Earth Sciences

41 Department of Mathematical Sciences  
(Applied Mathematics, Computer Science, Mathematics)

54 Department of Microbiology

61 Department of Physics

69 Department of Physiological Sciences



# CONTENTS



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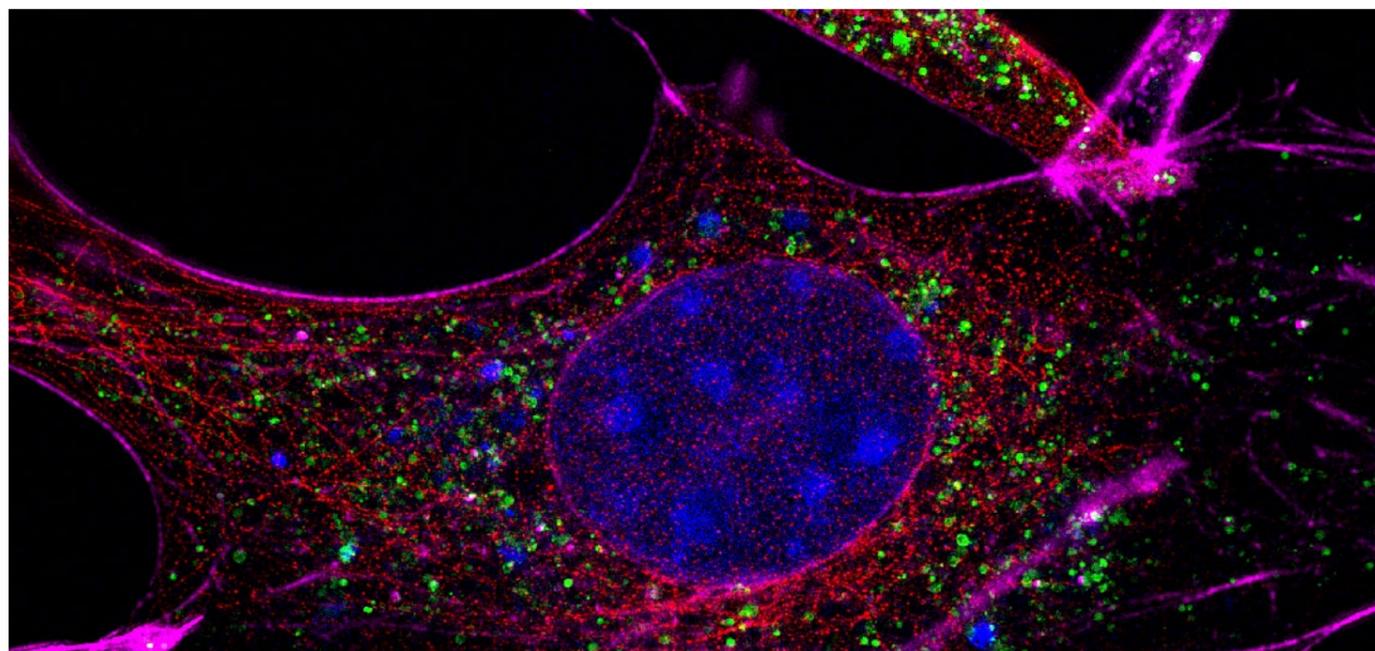
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## FROM THE DEAN'S OFFICE

When the Faculty of Science reflected on our one hundred year history in 2018, we acknowledged the difficult challenges our predecessors had to overcome – the 1918 plague, two world wars and a global economic depression. So yet again we are proud to say that, despite having had to face the multitude of challenges brought forward by an unprecedented global pandemic, the Faculty of Science continued to play a significant role in positioning Stellenbosch University as a leading, research-intensive university during 2020.

The Faculty also succeeded in successfully completing the 2020 academic year, with academic and support staff embracing Emergency Remote Teaching, Learning and Assessment (ERTLA) and other initiatives to continue providing a general formative education in the natural sciences and for professional degrees such as engineering, medicine and actuarial science.

### RECOGNITION OF ACADEMIC EXCELLENCE

We are exceptionally proud of the national and international recognition our researchers have received over the past year. Prof André Weideman from the Applied Mathematics Division received the South African Mathematical Society (SAMS) award for research distinction, as well as the SA Akademie's 2020 Havenga Prize for Physical Sciences. Prof Piet Steyn, emeritus professor in chemistry, received the Marloth Medal of the Royal Society, while Prof Selwyn Mapolie from the Department of Chemistry and Polymer Science was elected a Fellow of the South African Chemical Institute (SACI).

Several of our younger researchers already made their mark. Dr Prinessa Chellan from the Department of Chemistry and Polymer Science received a FLAIR fellowship of The Royal Society and African Academy of Sciences. Prof André de Villiers and Prof Harold Pasch, from the same department, made the 2020 Power List of Analytical Scientists, published by *The Analytical Scientist* annually to identify and acknowledge those making a significant impact in the field internationally. Dr Margaret Blackie from the Department of Chemistry and Polymer Science was awarded the South African Chemical Institute's chemical education medal.

### RESEARCH FOR IMPACT

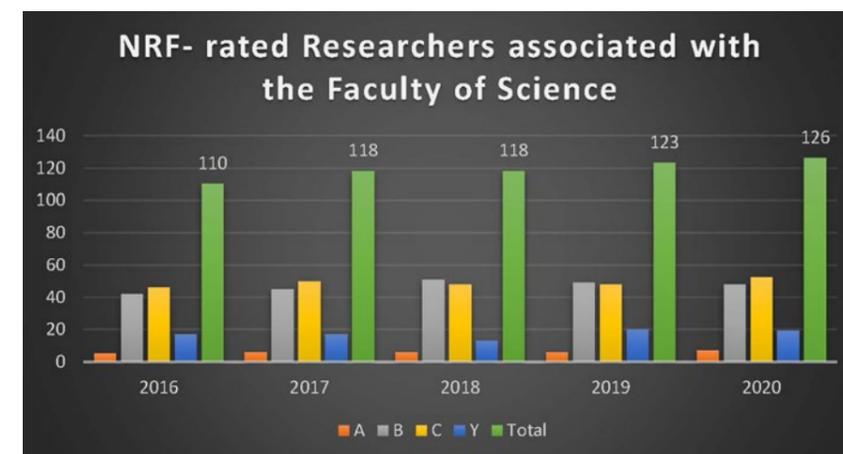
On the frontlines of technology and innovation, 2020 was an exceptionally fruitful year. The SharkSafe Barrier™ continues to rope in the awards. In 2020 it was the winner of the NSTF-Lewis Foundation's Green Economy Award, and early in 2021 it was recognised by the World Economic Forum's digital platform UpLink as one of its top ocean innovators. At the annual SU LaunchLab awards function, BioCODE received the top spin-out company for 2020 award, while the biotechnology company Immobazyme received the top newcomer for 2020 award. Immobazyme was established in 2020 by three of our postgraduate students in molecular biology and biotechnology. Because of all these innovations, the Faculty of Science also received the award for most spin-out companies for 2020 – they are BioCODE, PhagoFlux, Immobazyme and Biotikum. Another spin-out company from the Faculty, the Stellenbosch Nanofiber Company, won the spin-out excellence award for 2020. Our researchers also filed nine new patents during 2020.

### PATENTS FILED DURING 2020

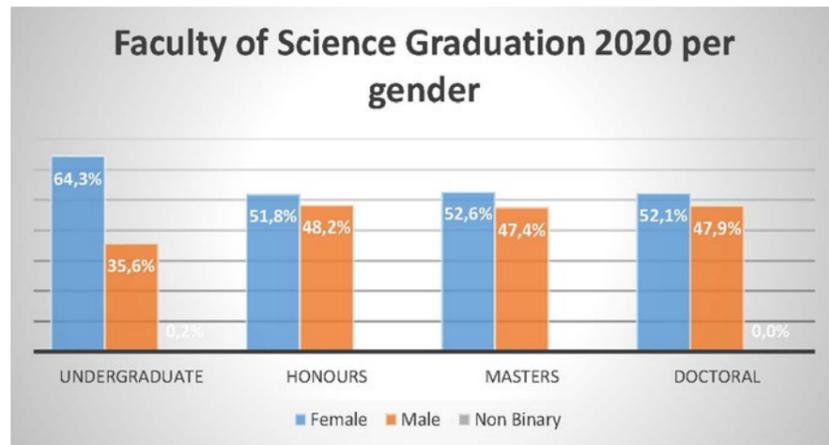
Method and apparatus for the production of fine fibres	Anton Eugene Smit and Ronald Douglas Sanderson
The SharkSafe Barrier	Craig O'Connell, Michael Rutzen, Sara Andreotti, Conrad Matthee
Method for preventing or treating microbial growth on a manufactured product	Marina Rautenbach, Wilma van Rensburg
Conjugate for treating malaria	Lubertus Klumperman, Paul Reader, Marina Rautenbach
Systems and methods for the detection of biomolecules	Leon Dicks, Willem Perold, Deon Neveling, Thomas van den Heever
A device for the detection of biomolecules	Christiaan Viviers, Willem Perold, Leon Dicks, Giles Maybery
Antimicrobial solution	William Joseph Cloete, Lubertus Klumperman
Recombinant yeast	Rosemary Cripwell, Willem Van Zyl, Shaunita Rose
Use of <i>Papiliotrema laurentii</i> as a bio-fertiliser	Leandra Moller, Alexander Valentine, Alfred Botha

In the context of the COVID-19 pandemic, several of our scientists are working at the cutting edge to develop epidemiological models to predict the spread of the disease, and to develop new tests to detect the spread of infection in urban and resource poor areas. There is more information about their research in the departmental reports.

Our researchers were also recognised by Stellenbosch University for their research outputs, namely Profs Cang Hui, Helmut Proding, John Measey and Dave Richardson, as well as those with the largest number of PhD graduates, namely Prof Bert Klumperman and Prof Emile van Zyl. Another five of our academic staff members obtained their NRF-ratings, bringing the total number of NRF-rated researchers in the Faculty to 128 in 2020.



Although we have seen a slight drop in postgraduate student enrolment numbers, we have not compromised on quality, as is evident from examiner reports and awards won by postgraduate students. For example, Dr Corneille Minnaar, a postdoctoral fellow in the Department of Botany and Zoology, received the Robert May early career research reward.

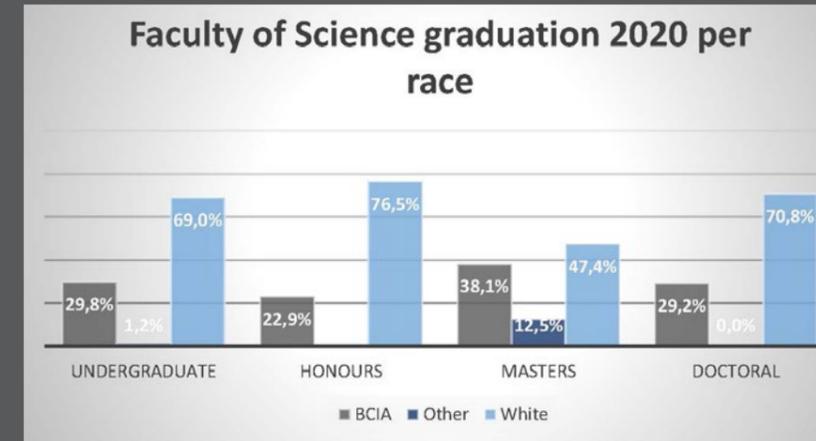


The funding of research projects and postgraduate students remain challenging, despite several new research contracts and collaborations having been signed. The DSI/NRF Centre of Excellence for Biological Invasions (CIB) has reached the end of its 15 year funding cycle and will see a 50% reduction in funding from the DSI-NRF in 2020 to 2022. Several of our South African Research Chairs will be reaching the end of their funding cycles, with Prof Bert Klumpermann's research chair in advanced macromolecular architectures ending in December 2020. It therefore remains important to diversify our third stream income and expand our national and international networks.

### TEACHING AND LEARNING

When the Level 5 lockdown regulations were announced in March 2020, Prof Ingrid Rewitzky, Vice-Dean of Teaching and Learning, took the lead in the implementation of emergency remote learning initiatives in order to continue our academic offering. Please take note of her special report on the next pages.

During 2020 two new programmes were accredited by the Council on Higher Education (CHE) – an MSc-degree in Machine Learning and Artificial Intelligence and a B-degree in Data Science. The BDatSci-degree is a four year multidisciplinary programme, offered by the Faculties of Economic and Management Sciences, AgriSciences, Arts and Social Science, and Science. The Centre for Bioinformatics and Computational Biology can also now offer a BScHons and PhD-degrees in Bioinformatics.



Our students also performed well. Mr Mpendulo Cele, a postgraduate student in mathematics, received the Southern Africa Association for the Advancement of Science (S2A3) bronze medal for the best master's study in one of the branches of science at SU. Mr Theo Busschau was awarded the SA Academy Junior Captain Scott Memorial Medal for the best MSc thesis in Zoology, and Mr Martin Page from the Department of Physiological Sciences was selected to attend the 70th Lindau Nobel Laureate Meeting. A team from the Computer Science Division won the Investec Hackathon. The Dean's medal was shared by MSc student in applied mathematics, Mr Fred de Villiers, and MSc student in physics, Ms Emma King. The SU Rector's award for excellent achievement in academics was awarded to Dario Trincherio (BScHons: Mathematics), Conrad Strydom (BScHons Physics), Jacobie Mouton (BScHons Computer Science), Bryce John Foster (BScHons Microbiology), Michael-Philip Smith (BScHons Chemistry and Polymer Science) and Sarah Selkirk (MSc Mathematics).

Dr Margaret Blackie received a SU Teaching Fellowship for 2020. The aim of the fellowship is to give academic staff in STEM disciplines access to analytical resources available in the suite of tools that comprises Legitimation Code Theory. Dr Blackie also received SU's Distinguished Teacher award, while Dr Ilse Rootman-le Grange, E-learning Instructional Designer, received the Developing Teacher award during SU's Teaching Excellence Awards function. Several of our lecturers were nominated by top-performing first year students as their most inspiring lecturers: Dr Sophie Marques, Prof Andrew Fransman, Dr James Gray, Dr Jacques Masuret and Dr Karin-Therese Howell, all from the Mathematics Division, and Prof Hugo Touchette from the Applied Mathematics Division.

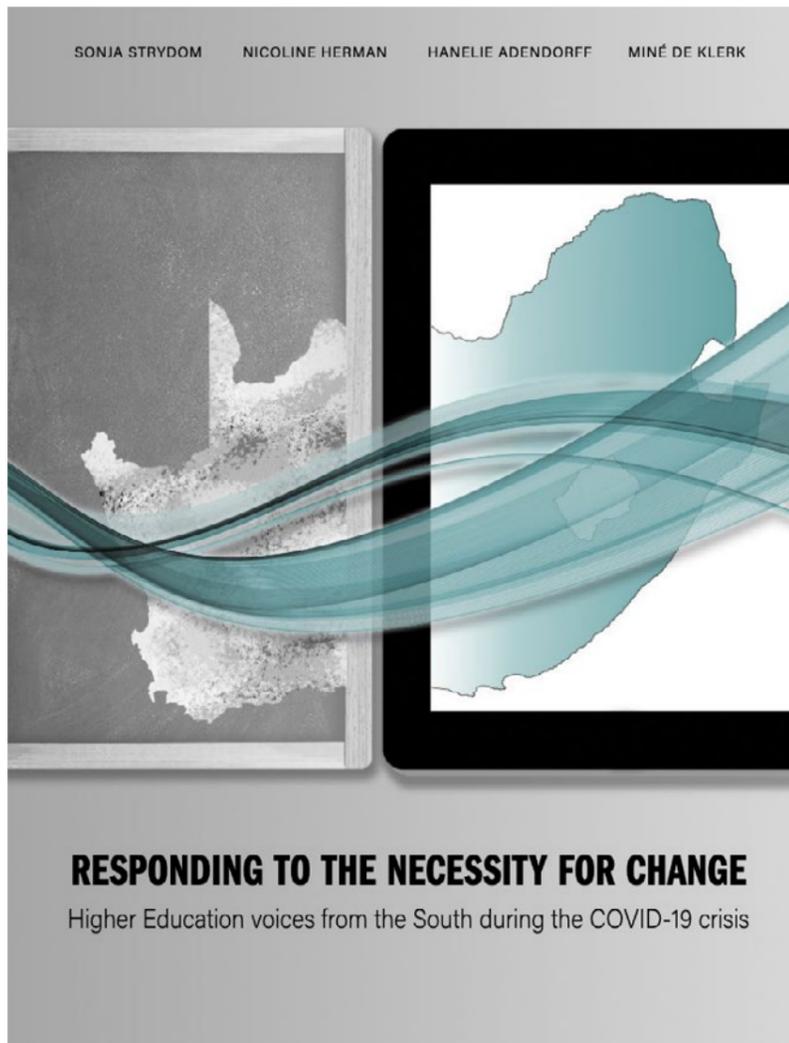
### IN CONCLUSION

At the beginning of 2020, we were saddened by the news that Prof Douglas Rawlings (68) passed away on Saturday morning 2 May 2020. Prof Rawlings was not only one of South Africa's foremost microbiologists, but also a leader in higher education management, including as acting dean of the Faculty of Science. In retirement he continued to play a key role in SU's early career academic development programme and as a member of the Research Ethics Committee.

As we reflect about the challenges we faced during 2020, we are fully cognisant of the fact that 2021 will hold its own share of challenges. In this regard I would like to acknowledge the outstanding contributions of every staff member that enabled us to complete the 2020 academic year under extraordinary circumstances, as well as the patience and dedication of our students. As the world struggles to recover from the socio-economic and health impacts of the pandemic, the higher education sector will have to adapt and become more cost-efficient to ensure our future sustainability.

*L Warnich*

PROF LOUISE WARNICH, DEAN: FACULTY OF SCIENCE



## RESPONDING TO THE NECESSITY FOR CHANGE

Higher Education voices from the South during the COVID-19 crisis

# TEACHING AND LEARNING DURING THE PANDEMIC

The COVID-19 pandemic made teaching, learning, and assessment in Science even more challenging and complex than usual. Many times during 2020, we asked ourselves what we did before this crisis, as every part of our days seemed to be overwhelmed with **emergency remote teaching, learning, and assessment (ERTLA)**, with endless MS TEAMS meetings within and beyond the University, and with an increased flow of communication documents and e-mails.

During the uncertainty and rapid move to ERTLA in March 2020 there was an intensity and sensitivity never experienced before. There was a need to provide clear guidelines for ERTLA, while being careful not to micro-manage; to communicate regularly with updates on national and institutional decisions, while being mindful of information overload and managing the expectations, anxieties and queries of colleagues and students; to respond quickly to concerns and issues raised by colleagues and students while being attentive to the differentiation of needs dependent on different coping mechanisms in times of uncertainty; to reassure and support colleagues and students using different ways of ensuring social connection and activity while appreciating that the transition to remote teaching, learning and assessment may feel overwhelming and may not be easy; and to trust that our colleagues and students are committed to completing the academic year and ensuring academic integrity.

The default approach to ERTLA during 2020 for modules offered by the Faculty of Science was:

- All lectures were offered as asynchronously and data light learning opportunities. That is, the lecturer material and short videos were uploaded on the SUNLearn site for the module and students were required to read and/or watch these in preparation for compulsory synchronous teaching and learning activities.

“Emergency remote teaching, learning, and assessment”



- For the compulsory synchronous and data light teaching and learning activities students were required to participate in an online chat session during the scheduled tutorial timetable slot for the module or a virtual practical experience during the scheduled practical timetable slot.
- There were no on-campus sit-down assessment opportunities at the end of the first semester. All modules were encouraged to complete the formative and summative assessments online while maintaining the validity and reliability of the assessments.

During the second semester, the Faculty invited back to campus second-year and third-year students to complete the on-campus lab work and field work components of modules.

## HELPING STUDENTS TO ACCESS DATA AND ELECTRONIC DEVICES

The implementation of ERTLA required all students to have access to an electronic device with internet access. Institutional funding made it possible for students to obtain loan laptops as well as monthly data bundles. SU acknowledged the many challenges students would experience during 2020 by announcing in April that all students registered for the 2020 academic year will automatically be readmitted for 2021, regardless of academic performance in 2020. Students who did not pass a first semester module in 2020, but met



Dr Matthew Mayne used high resolution web-cameras, a lapel microphone and a bit of creativity to deliver a rock identification class remotely. Image supplied

applicable subminimum criteria, were also granted the opportunity to write an additional assessment in January/February 2021. Throughout 2020, the Faculty Management Team worked closely with the Natural Sciences Student Committee (NSC) and the class representatives to hear and respond to students' concerns and challenges with ERTLA and to recommend support of the Centre for Student Counselling and Development (CSCD).

## NETWORKING OPPORTUNITIES FOR LECTURERS

The **Science Teaching and Learning Hub**, together with the Division for Learning Enhancement, provided much-needed networking opportunities for lecturers. This included webinars for preparing for ERTLA, Q&A webinars as well as faculty-specific webinars such as “Exhale! Look back and see how far we have come”, held in June and “Looking ahead to Science T&L 2021”, held in November. The weekly Science Weekly Virtual Water-Cooler meetup, with no agenda, was an informal meetup to hear how colleagues were really experiencing this new teaching and learning space. Everyone was welcome to share, rant, cry (or simply listen) and ask advice about a teaching and learning challenge.

As colleagues and students adapted to remote teaching, learning, and assessment, it was amazing to observe colleagues collaborating on building knowledge of remote teaching, learning and assessment, as they do in research. In particular:

- The paper “Successful online learning and teaching is not about technology – it is about humanizing” by Dr H. Volschenk, Dr I Rootman-Le Grange, and H. Adendorff was prepared for the book *Responding to the necessity for change: Higher Education voices from the South during the COVID-19 crisis* published in 2020.
- The Science Teaching and Learning research group has been reflecting on their experience and contributing

to the Science T&L and COVID-19 collaborative research project initiated by Dr Bjorn von der Heyden.

- As part of the virtual talks@stellenboschuni, Dr Margaret Blackie shared her experience of teaching in 2020 in a podcast entitled “Thanks to the lockdown, new challenges in education opened up new opportunities”.

## INNOVATIVE TEACHING, LEARNING AND ASSESSMENT

The Faculty received further institutional funding for ERTLA and hybrid learning, resulting in some innovative teaching and learning and assessment projects. This reminded us of how agile and responsive our colleagues are at all levels in academic departments and PASS environments. Four programme renewal projects were prioritised and implemented in 2020:

- The move to ERTLA in 2020 required rethinking of assessment practices and highlighted the challenges of the academic integrity and reliability of remote assessment. The **assessment strategy** for all undergraduate modules was redesigned to incorporate different purposes, methods and tools for assessment – including multiple choice questions (MCQs), open book assessment, problem-based projects, and portfolios.
- Flexible assessment was implemented in all undergraduate modules during 2020 which inspired the Department of Earth Science to change from the traditional examination model to a specifically designed flexible assessment model from 2021.
- All departments offering practicals or field work designed and implemented a more **hybrid experience** with certain practical skills developed in a virtual setting such as, [Learning Science UK](#) and other in the on-campus laboratories or in the field.

- Mathematics Upskilling Learning Units (ULUs) were designed and developed by Dr J Masuret and Mrs EJ Burger from the Mathematics Division together with Mr R Randall from the Faculty of Economic and Management Sciences and the Centre for Learning Technologies. The [Math ULUs](#) are intended for individuals who wish to improve their mathematical proficiency by mastering foundational mathematical concepts and procedures that first-year mathematics require. From 2021, the Math ULUs will be a compulsory hybrid learning part of all Mathematics modules taken currently by Extended Degree Programme (EDP) students in Science, AgriSciences, Engineering, Economics and Management Sciences, and they will be strongly recommended for all first-year Science and AgriSciences students who are registered for a first-year mathematics module.

With each change in national lockdown level in 2020 there was a need to rethink the support structures and communication channels, to find the appropriate level of care, and to plan for future scenarios as the pandemic continued. While the need for regular communication of guidelines may have decreased, the need for care increased as colleagues and students were feeling the impact of the transition to remote teaching, learning and assessment and the ongoing uncertainty of the pandemic. Our approach was to build networks, to allow for emergence of innovative ideas and solutions, to provide communication and feedback with sensitivity, and to be agile in our response to the changing context.

At the annual SU Scholarship of Teaching and Learning (SoTL) conference, held virtually on 4 November, there was a space for celebration, appreciation, and reflection on our COVID-19 experiences in the e-environment, the thoughtful and scholarly teaching and learning approaches followed, and the innovative ideas and solutions that have evolved during this challenging time for colleagues and students. The CARE-note

opening session (instead of a keynote address) involved the collective SU academic community reflecting on and sharing the broad idea of care during the time of ERTLA at SU. From the Faculty of Science, Prof I Rewitzky, Vice-Dean: Teaching and Learning, and Dr H Adendorff, Senior Advisor for Science at the CTL, participated in representing the management voice and PASS voice, respectively. Several colleagues once again found time to prepare and present their teaching and learning initiatives, namely:

- 'Life happens: Designing a video game for learning (in 2020)' by C. Pretorius, Department of Chemistry and Polymer Sciences, together with Dr H. Adendorff and Dr I. Rootman-le Grange.
- 'Harnessing the beast: Taking COVID-19 on a Cytology autonomy tour' by Dr M Mouton, Department of Botany and Zoology.
- 'Interpreting Physics – Discoveries in translation' by Dr P Southey, Department of Physics, together with S. de Jager and R. Lötter.
- 'The evaluation of Emergency Remote Learning Assessment for first-year and second-year mainstream Mathematics' by Dr K. Howell, Mathematics Division, together with Dr H. Adendorff, and Dr I. Rootman-Le Grange.
- 'Cooperative learning activities in large Physiology classes can improve student performances' by Prof F Essop, Department of Physiological Sciences.
- 'Repurposed student educational videos: A useful archive for online learning material' by Dr B. von der Heyden, Department of Earth Sciences.



Dr Martin Klausen teaching undergraduates from his home office during hard lockdown regulations in 2020. Image supplied

## IN CONCLUSION

The Faculty of Science completed successfully the 2020 academic year in mid-December 2020 thanks to the commitment of all staff and students in Science. Staff were rewarded with a special gratuity. At the Faculty of Science virtual graduation ceremony on December 2020, there was the opportunity to celebrate all the final-year students graduating and to recognise all non-final year students who completed the academic year. From the students' feedback there was an appreciation for the clear communication of expectations, timeous feedback, availability at the start of each week of the detailed learning plan with resources, video lectures that could be re-watched as needed, and additional material providing different perspectives, applications and context for the curriculum content. Students acknowledged the need for effective time management and self-paced learning, which was welcomed by many. Assessments were identified as the biggest challenge by students since the assessment practices were unfamiliar and the format of the answers – typed vs handwritten – also added a level of complexity. In addition, it was noted that the questions required deeper understanding and/or more application due to the open book approach for ERTLA. There was an element of hope that at least some of the online learning experience will be sustained beyond the COVID-19 pandemic.

Pass rates confirm that an average module pass rate of 84.5% for the first year students was maintained during 2020, and an average module pass rate of 87.6% for first to third year students.

Looking forward, there is much consideration of the issues raised for the higher education sector – for

example, systemic inequalities, the digital divide – and how it might change the future for us. Could this transition have been approached differently? Could it be the catalyst for rethinking teaching and learning practice that has been so long awaited? Alongside the many questions, there has been some increased recognition that online teaching, learning, and assessment may offer significant benefits for supporting student learning, albeit with a greater investment of time and resources to develop and offer, than face-to-face on-campus experience.

In the Faculty of Science the experiences of 2020 confirm that there is a future for a more hybrid learning experience – differentiating the on-campus experience from the remote/online experience. The time is perfect for rethinking our teaching, learning, and assessment practices.

PROF INGRID REWITZKY, VICE-DEAN: TEACHING AND LEARNING

# DEPARTMENT OF BIOCHEMISTRY

## RESEARCH INTERESTS

Steroid hormone biosynthesis and function  
 Progestins in female reproductive health  
 Evolution and detection of viruses and bacterial pathogens of potatoes and fruit trees  
 Ostrich pathogen detection, microbiome analysis and antibody production  
 Pathogen diagnostics and control – PCR, Sequencing, ELISA and field trials for vaccine evaluation  
 Molecular systematic and evolutionary studies of plant groups in southern Africa  
 Antimicrobial peptides – isolation, characterisation and 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)  
 Antimicrobial drug design focused on cofactor usage  
 Cell stress and protein folding in infectious diseases  
 Cell stress response as druggable target (drug design and screening)  
 Mathematical and computational systems biology

## RESEARCH HIGHLIGHTS

**Prof Donita Africander** was invited to review the current understanding of progestins used in menopausal hormone therapy and breast cancer risk for Elsevier's *Current Opinion in Endocrine and Metabolic Research*. She also received funding (five-year grant) from the National Institute of Health as a co-investigator on a project with Prof Janet Haggood at the University of Cape Town (UCT). She was invited by the Institute of Metabolism and Systems Research at the University of Birmingham (UK) to be a panellist for an online discussion on the lived experiences of black scientists, specifically scientists that have made seminal contributions to endocrinology and metabolism research. The panel consisted of four members at different stages in their career and included conversations on the challenges faced by black scientists, race equality and inclusivity in research/academia.

**Prof Dirk Bellstedt** published six papers in diverse journals. Two of these publications were in the field of plant molecular systematics and plant biology. Seven new species of African fishes, identified by means of DNA sequencing and phylogenetic analysis, were described



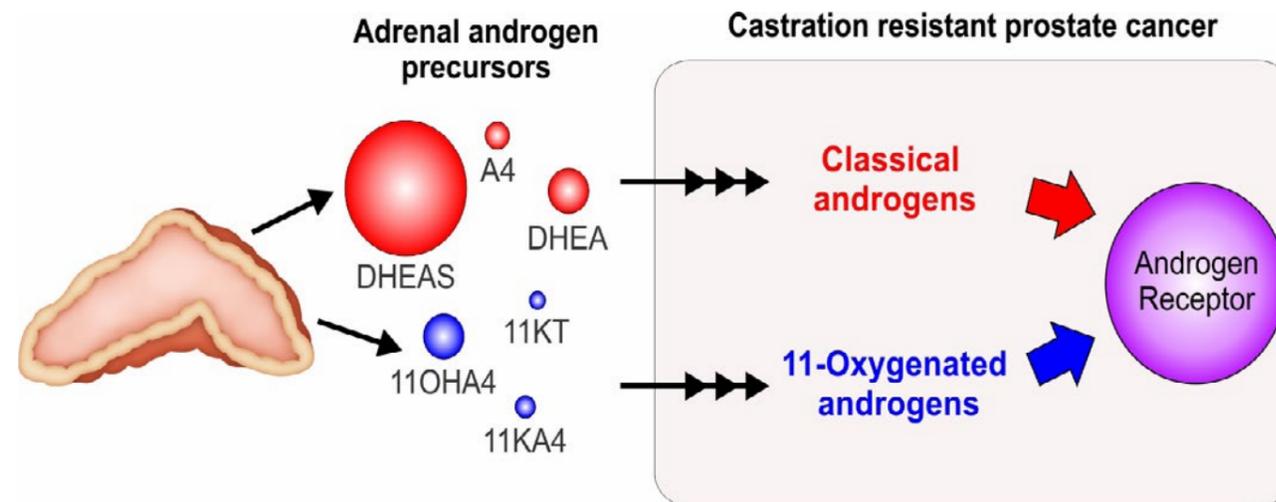
*Nothobranchius attenboroughi*.  
Photo: Brian Watters

including one in honour of the famous conservationist and commentator Sir David Attenborough. *Nothobranchius attenboroughi* occurs in the famous Serengeti National Park in Tanzania. One paper addressed a burning question in biology on the building blocks and the origins of life.

**Dr Annelise Botes** has been involved in ostrich-infecting mycoplasma research since the early 2000s. In collaboration with a group from the Institute of Bacteriology Mycology and Hygiene at the University of Veterinary Medicine in Vienna, a formal description of two of the three ostrich-specific mycoplasma species has now been published and their draft genomes have been made available on the GenBank database. Dr Botes's

research group has also been able to finalise a microbiome study that evaluated the change in microbial content of ostrich chicks raised under natural vs intensive conditions. The results provide an understanding of the impact of production systems on intestinal health and can be used in the future management of gut-related health problems in ostrich chicks.

**Dr Marianne de Villiers** published her research as corresponding author on stable and potent *N*-substituted pantothenamides as potential antiparasitic agents in ACS Infectious diseases. Internationally she has active collaborations with Prof Kevin Saliba and Dr Christina Spry at the Australian National University's Research School of Biology. Nationally she collaborates with Prof Lyn-Marie Birkholtz at the Department of Biochemistry at the University of Pretoria, Dr Rencia van der Sluis in the Focus Area for Human Metabolomics at North-West University. She also collaborates with Prof Karl Storbeck, Prof Erick Strauss, Prof Tawanda Zininga and Prof Dirk Bellstedt at the Department of Biochemistry and Dr Katherine de Villiers at the



Recent findings from Prof Storbeck's lab show that a previously overlooked group of adrenal derived androgens, known as 11-oxygenated androgens (shown in blue), make a hitherto unrecognised contribution to the androgen pool that drives Castration Resistant Prostate Cancer.

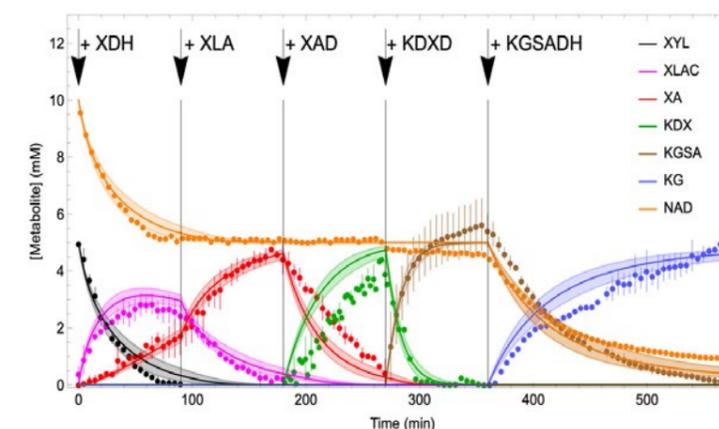
Department of Chemistry and Polymer Science, all from Stellenbosch University.

Three Masters students graduated from **Prof Johann Rohwer's** laboratory. Two of his long-standing collaborations culminated in the publication of research articles. Together with the research group of Prof Jonathan Gershenzon from the Max Planck Institute for Chemical Ecology in Jena, Germany, he is investigating the regulation of isoprene production in various plants. A joint paper describing the effect of drought on the isoprene synthesis pathway in spruce was published in *Frontiers in Plant Science*. The collaboration with Dr Ché Pillay from the University of KwaZulu-Natal in Pietermaritzburg on the computational systems biology of redoxin systems is ongoing. They developed a novel concept, the "redox charge", based on easily measurable quantities, to quantify the status of these systems. This can serve as a proxy for how active the pathway is, something that is much harder to measure directly. The study was published in *Archives of Biochemistry and Biophysics*.

**Prof Karl Storbeck** continued his work investigating the role of 11-oxygenated androgens and published a paper describing the metabolism of the potent 11-oxygenated androgen, 11-ketotestosterone, together with Prof

Jacky Snoep and UK collaborators Prof Wiebke Arlt and Prof Jeremy Tomlinson from the Universities of Birmingham and Oxford, respectively. He also published a review article on the role of adrenal androgens in prostate cancer together with his collaborator Prof Elahe Mostaghel from the Fred Hutchinson Cancer Research Centre in Seattle, USA.

**Prof Storbeck** continued his collaboration with Prof Nils Krone from the University of Sheffield in the UK and published two papers using Zebrafish as model organisms for human endocrine disorders. He also collaborated with Prof Tulay Guran from Marmara University in Turkey on a study characterising beta-hydroxysteroid dehydrogenase 2



In vitro reconstitution of the Weinberg pathway. The pathway is important for bioconversion of lignocellulosic biomass, and describes the oxidation of xylose to alpha ketoglutarate, in five enzyme catalysed steps. In the figure the five enzymes are added consecutively with 90 minutes intervals and the pathway intermediate dynamics, as quantified via NMR, are shown. The solid lines and shaded areas show model predictions and confidence intervals for the conversions. The work was published in *Nature Communications*. Image: Jacky Snoep

deficiency in pediatric cases. Finally Prof Storbeck was invited to write an invited review on the use of Mass Spectrometry in Breast Cancer research, which was published in *Current Opinion in Endocrine and Metabolic Research*.

A long running project together with Prof Bettina Siebers of the University of Duisburg/Essen has culminated in the formulation of a modelling workflow that is completely transparent and reproducible. The workflow was made explicit for a project on the Weimberg pathway, and published in *Nature Communications*, with **Prof Jacky Snoep** and **Dr Dawie van Niekerk** as co-authors.

Similarly in a collaboration with the group of Prof Mattias Goksör and Dr Caroline Beck Adiels from the Department of Physics at the University of Gothenburg, Snoep and van Niekerk developed a microfluidic cell that mimics diffusion limited substrate supply to organs, to simulate glycolytic oscillations and wave propagation in yeast cells. This work was accepted for publication in the *Proceedings of the National Academy of Sciences of the USA*.

**Dr Tawanda Zininga** was a finalist in the BioSolveIT Scientific Challenge, held in the autumn of 2020. His project "Identification of Small Molecule Inhibitors of Hsp90/Hsp70 Chaperone System" was featured as project of the week on the BioSolveIT website and was additionally announced on LinkedIn and Facebook.

## RESEARCH ACTIVITIES

**Prof Donita Africander** served on the editorial board of the *Journal for Ethnopharmacology* and guest editor for *Frontiers in Immunology*. 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 Narendra Kumar from the Population Council at Rockefeller University, New York City, USA. She attended the online Society for Endocrinology British Endocrine Society (SfE BES) conference from 16-20 November 2020.

**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 2020. He served on the Research Ethics Committee: Animal Care and Use, of Stellenbosch University. 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.

**Dr Annelise Botes** has an active collaboration with Dr Adriaan Olivier who is the industry veterinarian for the South African Ostrich Business Chamber. Dr Botes also acted as reviewer for *Frontiers in Veterinary Science*.

**Prof Ann Louw** attended an online Society for Endocrinology and British Endocrine Society conference from 16 to 20 November. She was invited to be part of a Science Café Stellenbosch at Woordfees 2020 in March to present her research on the cancer preventative activities of *Cyclopia* together with Prof Lizette Joubert and Dr Cecelia Bester in a talk entitled "The story of Honeybush: from the Langkloof to world class tea". Unfortunately, she broke her arm just before the event and could not attend. Prof Louw collaborates within her own department with Prof Johann Rohwer and Dr Nicky Verhoog on *Cyclopia* and GR dimerization, and with the Agricultural Research Centre (ARC) Infruitec-Nietvoorbij's Dr E Joubert and Prof D de Beer. Other collaborators include researchers from the Post-Harvest and Wine Technology Division, on *Cyclopia*; the Vlaams Institute voor Biotechnologie (VIB), and Prof Claude Libert from the University Ghent in Belgium, on GR dimerization; Prof Gunter Volmer and Oliver Zierau from the Technische Universität Dresden, Germany, on *Cyclopia* and breast cancer; and Prof Holger Reichardt from the University of Göttingen, Germany, on GR dimerization. Prof Louw attended a meeting with Ms Anisa Khan, Manager: Global Partnerships and Internationalisation Support at SU, and Ms Katharina Schmitt, the Head of the International Office at TU Dresden, to discuss potential interactions between SU and TU Dresden emanating from a research visit by colleagues from TU

Dresden in 2019. Specifically, three potential interactions were discussed: an International Research Training Group on *Cyclopia*, TU-Dresden plant master courses and TU-Dresden Summer School. Prof Louw served as a guest editor for the *Journal of Steroid Biochemistry and Molecular Biology* (SBMB) Virtual Special Issue on Steroids and Disease and is an associate editor for *Frontiers in Pharmacology's* sub section, Ethnopharmacology.

**Prof Marina Rautenbach** served as guest associate editor for *Frontiers in Antimicrobials, Resistance and Chemotherapy*. She is also a review editor for *Frontiers in Chemical Biology* and serves on the editorial boards of *BBA Biomembranes* and *Journal of Microbiological Methods*. She was invited as visiting professor to Sapienza University (Italy) and two keynote lectures at peptide conferences in 2020, but due to the COVID-19 restrictions these were postponed. Prof Rautenbach has active collaborations with colleagues in Microbiology, Prof Leon Dicks, Dr Heinrich Volschenk and Prof Wesaal Khan, in the search for new antibiotics from environmental samples. She also collaborates with Prof Bert Klumperman from the Department of Chemistry and Polymer Science on novel nanoformulations of antimicrobial peptides. In the Department of Biochemistry, she collaborated with Prof Karl Storbeck and Drs S Abels and M Lilly from the Cape Peninsula Technical University on phospholipid metabolism in cancer cells. She also has a long-standing active collaboration with Prof Marietjie Stander from the LC-MS CAF on mass spectrometry of biomolecules. On international level she collaborates with Prof M-L Mangoni from Sapienza University in Rome, Italy, on the application of peptides in self sterilising materials, specifically to create antiviral materials. Further collaborations are on the biophysical aspects of peptide self-assembly in which she works with Prof B Bechinger at Strasbourg University in France, Prof HH Paradies at Jacobs University in Bremen, Germany, Prof T Parker from the Science and Technology Council, UK, Dr P Neetling from SU's Department of Physics, and Dr JB Joshi at Dr HS Gour Central University in Sagar, India. Prof Rautenbach has licenced collaborations with industry, such as FlexiGreen SA on the commercialisation of her patent on antimicrobial materials and with Gowan USA on antimicrobial

peptide formulations in agriculture. Her group, the BIOPEP™ Peptide Group also celebrated their 21st anniversary as supplier of the peptide antigens for a hepatitis C virus (HCV) detection kit to a large international company Diasorin and its predecessors, Abbott and Murex. Over the past 21 years, more than 250 million HCV tests were done using peptides produced by the BIOPEP™ Peptide Group.

Together with his postgraduate students, **Prof Johann Rohwer** attended the hybrid conference of the International Study Group for Systems Biology during September 2020. Because of the Covid-19 pandemic this was a hybrid meeting being held both in-person in Austria and online. One of his PhD students, Chris Barry, gave an oral presentation on his research on the modelling of cellular peroxiredoxin systems. Prof Rohwer also presented a lecture at the South Africa-Germany bilateral workshop on "Systematic profiling of multicopper oxidases", where he spoke about the PySCeS computational systems biology software developed in his research group.

**Prof Rohwer** is a member of the international STRENDA (Standards for Reporting Enzymology Data) Commission and chairs AHASA, the Alexander von Humboldt Association of Southern Africa (South-Western chapter). He currently serves as associate editor for *BMC Bioinformatics*, as review editor for *Frontiers in Plant Science* (section Plant Systems Biology), serves on the editorial advisory board of *In Silico Plants*, a new online journal specialising in plant systems biology, and is an editorial board member of the *Journal of Experimental Botany*. 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, Germany, on flux and control analysis of isoprene synthesis in plants.

**Prof Karl Storbeck** serves as the treasurer for the South African Society

for Biochemistry and Molecular Biology (SASBMB) and as a member of the Chromatography Society of South Africa committee in the Western Cape. He also serves as an associate editor for the *Journal of Steroid Biochemistry and Molecular Biology* and on the editorial boards of *Steroids*, and *Molecular and Cellular Endocrinology*. Prof Storbeck also served on the NRF COVID-19 rapid response panel.

Prof Storbeck has active collaborations within the Department and with Prof Janet Hapgood from the University of Cape Town on the metabolism of progestins. His international collaborators include Prof Wiebke Arlt from the University of Birmingham's Institute of Metabolism and Systems Research (UK) on the role of 11 $\alpha$ -oxygenated androgens in health and disease, Prof Jeremy Tomlinson from the Oxford Centre for Diabetes, Endocrinology and Metabolism at the University of Oxford (UK), on the AKR1D1 mediated metabolism of 11 $\alpha$ -ketotestosterone; Prof Nils Krone from the Department of Oncology and Metabolism at the University of Sheffield (UK), on development of zebrafish models for steroidogenic disorders; with Prof Tulay Guran from Marmara University ( Turkey), on the role of 11 $\alpha$ -oxygenated androgens in steroid disorders; with Prof Elahe Mostaghel from the Fred Hutchinson Cancer Research Center, Seattle (USA), on the role of 11 $\alpha$ -oxygenated androgens in castration resistant prostate cancer.

**Prof Jacky Snoep** and **Dr Dawie van Niekerk** attended the hybrid conference of the International Study Group for Systems Biology held in Innsbruck, Austria from 10 to 12 September 2020 and online. They both presented posters covering their research on yeast glycolytic oscillations and the Weimberg pathway, and two of their students, Ms Shade Horn and Mr Erik Rust, gave oral presentations. Their research was also presented at the annual SACEMA Research Days conference from 7 to 9 Sept 2020 by themselves and a number of students in oral presentations.

**Prof Snoep** and Dr van Niekerk are involved in the following collaborations: Prof MF Essop from Stellenbosch University; Prof L-M Birkholtz from the University of Pretoria; Prof V Mizrahi from the University of Cape Town; Prof B Bakker from the University of

Groningen (Netherlands); Prof C Goble from the University of Manchester (UK); Prof HV Westerhoff from the Vrije Universiteit Amsterdam (Netherlands); Prof Mattias Goksör from the University of Gothenburg (Sweden); Dr Matthias König from the Humboldt-University Berlin (Germany); Prof Dr Bettina Siebers from the 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*.

**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 Ody Sibon from the University Medical Centre Groningen, Department of Cell Biology in the Netherlands, and Prof Cindy Dowd from George Washington University (USA).

**Dr Tawanda Zininga** collaborates with Dr Ofentese Pooe and Prof Rajshekhar Karpoomath at the Department of Biochemistry and Pharmaceutical Chemistry, University of KwaZulu-Natal; with Prof Karen Sliwa-Hahnle at the Cape Heart Institute and Hatter Institute for Cardiovascular Research in Africa, University of Cape Town; with Prof Addmore Shonhai and Dr Adelle Burger at the Department of Biochemistry, University of Venda; and with Prof Tim-Wolf Gilberger at the Bernardt Nocht Institute of Tropical Medicine, Hamburg, Germany. He is registered with the American Society of Clinical Pathology (ASCP) as International Medical Technologist, with the South African Council for Natural Scientific Professions (SACNASP) as Biological Scientist, and with the Medical Laboratory and Clinical Scientists Council Zimbabwe as Chemical Pathologist.

## ACADEMIC AFFAIRS

The Covid-19 pandemic and the concomitant rapid move to emergency remote learning, teaching and assessment required an immense effort from all staff members to keep the academic programme on track. Despite these challenges, students in the undergraduate

biochemistry modules achieved excellent pass rates.

A total of 19 students graduated with BSc Hons in Biochemistry (five obtained a distinction), and eight Masters as well as eight doctoral students obtained their degrees during 2020.

## STAFF MATTERS

**Dr Tawanda Zininga**, previously from the University of Venda, joined us as a Lecturer from January 2020 to take up the vacant position left by the retirement of Prof Dirk Bellstedt at the end of 2019. Ms Anita Februarie, senior technical assistant in the Department, retired at the end of 2020 after more than 40 years of service.

## SOCIAL IMPACT

In this Covid-19 year, **Prof Dirk Bellstedt** wrote two articles on effects of the virus in the popular press and assisted reporters to write two further articles to correctly inform the public about the disease and vaccines. He also gave a well-attended online lecture on the topic for the Faculty of Science's Science Café Stellenbosch series. Various interviews were given to local radio and TV stations.

**Dr Annelise Botes** together with her laboratory manager, Ms Lihandra Prinsloo, and postgraduate student, Ms Felicia Wells, presented a molecular biology practical to the grade 12 learners at HMS Bloemhof in Stellenbosch, as part of their Life Sciences practicals. This was done in collaboration with the Plant Breeding Laboratory in the Department of Genetics.

**Prof Ann Louw** was invited to address the new students of Nemesia residence on her research career in January.

## FUNDING

### South Africa

BIOPEP™ Peptide Fund  
Cancer Association of South Africa (CANSAs)  
Medical Research Council (MRC)  
NRF Competitive Support for Unrated Researchers (CSUR)  
NRF Competitive Programme for Rated Researchers (CPRR)  
NRF SACEMA/SARCHI research chair in mechanistic modelling of health and epidemiology  
South African Centre for Epidemiological Modelling and Analysis (SACEMA)  
Stellenbosch University Subcommittee B  
Stellenbosch University Faculty of Science

### Germany

German Volkswagen Foundation

### United Kingdom

Biotechnology and Biological Sciences Research Council (BBSRC), FAIRDOM grant  
National Institutes of Health GCRF START grant from the STFC/UKRI (UK)

### United States of America

National Institutes of Health (NIH)

## 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
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
	Dr Dawie van Niekerk	Computational Systems Biology
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

## STAFF LIST

### Academic:

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

### Extraordinary professors:

Prof WCA Gelderblom

### Emeritus professors:

Prof DU Bellstedt  
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 K Mogwera  
Dr D Neveling  
Dr W Roos  
Dr W van Rensburg  
Dr JA Vosloo

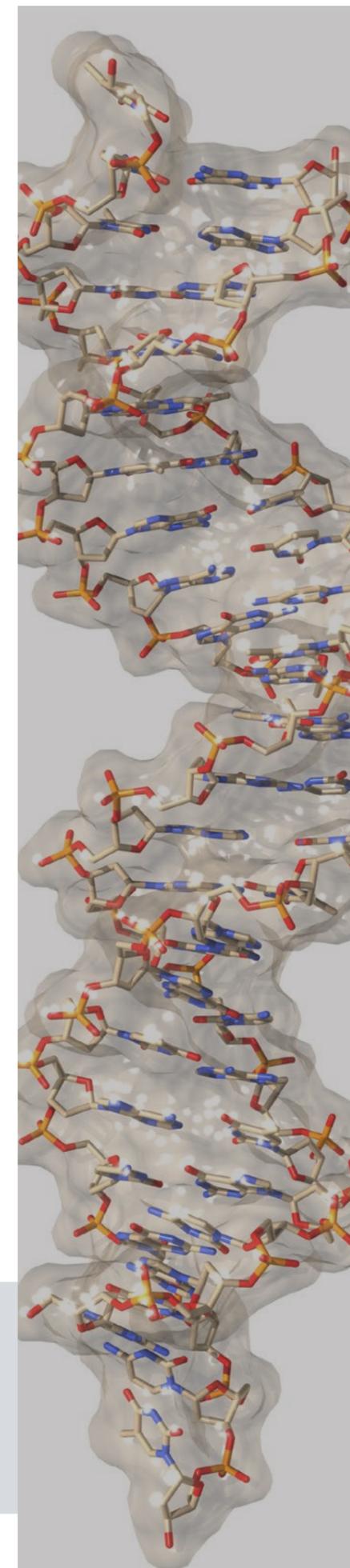
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# DEPARTMENT OF BOTANY AND ZOOLOGY

## RESEARCH INTERESTS

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

## RESEARCH HIGHLIGHTS

### ACOUSTIC MONITORING OF INDIVIDUAL DOLPHINS TO HELP CONSERVATION EFFORTS

The SWORD (Signature whistles for Occurrence, Recapture and Density) project has made good progress in 2020. The project's principal investigator is Dr Tess Gridley, postdoctoral fellow in the department, working in collaboration with Dr Simon Elwen, an extraordinary appointment in the Department of Botany and Zoology, and PhD students Sasha Dines from SU and Jack Fearey from UCT.

Each dolphin uses its own whistle contour when communicating with other dolphins and in this way they act somewhat like a name in human society. These whistles,

called 'signature whistles', remain very stable over time – so that dolphins recorded decades apart are found to use exactly the same whistle contour. In research published in the *Journal of Mammalogy* in 2020, we were able to calculate a population abundance estimate for Namibia's coastal bottlenose dolphins, using signature whistles by applying a statistical method called mark-recapture. The calculated abundance estimate was encouraging and very similar to the number calculated through the standard method, which uses photo-identification of the dolphin's dorsal fin. The research generated considerable media interest and was featured on national and international radio (Cape Talk, BBC radio 4) as well as printed media.

In 2020, we further developed this research to focus on the locally endangered Indian Ocean humpback dolphin (*Sousa plumbea*) which has an estimated population size of 250 to 500 individuals in South Africa. The population is data deficient and threatened by human activities including noise pollution, over fishing, boat interactions, shark nets, and coastal construction. Therefore, data collection about the species will be invaluable to inform conservation action and management options allowing for their improved protection.

The dolphin research conducted in Mozambique and Richards Bay in 2020 (prior to Covid restrictions), provides strong evidence for signature whistle use in humpback dolphins, from which a first catalogue of signature whistles has been generated. We were able to conduct limited fieldwork throughout 2020 to generate data for acoustic species classifiers. We will continue this research in 2021, and hope to provide important information on the whereabouts of humpback dolphins, and calculate abundance and density estimates from signature whistle monitoring. – Dr Tess Gridley



A bottlenose dolphin off the coast of Namibia. Photo: Simon Elwen

### OXALIS HIGH 'LIGHTS' IN A DARK 2020

The dark Covid-19 narrative of 2020 will be shared for many years to come, but nature also provided her own 2020 narratives, and these need to be celebrated. After a beautiful autumn in the Cape Flora, we entered into a wonderfully wet Cape winter season, filling our dams and nourishing our native flora. And nature responded in an amazing way, resulting in one of the best Namaqualand flower displays in years. Navigating carefully between oscillating travel restrictions and lockdown rules, the *Oxalis* team explored far and wide, initiatives that were rewarded by spectacular discoveries of new, rare or obnoxiously elusive species that we have been searching for years.

One of the first discoveries was made on the farm De Brugge near Piketberg, where we excitedly found a delicate multifoliolate species tentatively believed to be *Oxalis variifolia*, a critically endangered and possibly extinct species. DNA analyses confirmed its uniqueness, but we will only know for sure if this is indeed a species risen from the dead once we carefully compare it to type specimens.



Elusive *Oxalis* species rediscovered during 2020. A. *Oxalis* cf. *variifolia* rediscovered on the farm De Brugge near Piketberg. Photo: Frikkie Becker B. The elusive *O. macra* finally rediscovered after a 22-year search. Photo: Brian du Preez

If not *O. variifolia*, this species is new to science, as it does not match any other known Cape *Oxalis* species. PhD student Brian du Preez spent much of 2020 searching for *Indigofera* species, a genus he is revising as part of his PhD. This led him to remote places across the Cape, resulting in the discovery of many interesting *Oxalis* species too. Following a lead provided by the well-known environmentalist Dave Pepler, Brian discovered *O. macra*, a species historically known from only three populations, none of which we have been able to relocate over the past 22 years. He then discovered a beautiful species that resembles *O. blastorrhiza* near Klawer. Both DNA sequence data and a suite of morphological traits strongly suggests this to be a new species.



New *Oxalis* species discovered during 2020. A. The new *Oxalis* species Brian du Preez discovered near Klawer. Photo: Brian du Preez. B. The spring flowering new *Oxalis* species discovered in Boesmanskloof by Frikkie Becker. Photo: Frikkie Becker

MSc student Frikkie Becker discovered another beautiful new species in Boesmansklouf near Rivieronsderend. Superficially these small plants look similar to both *Oxalis depressa* and *Oxalis kamiesbergensis*, but both its locality and flowering time is totally unique. This species reaches peak flowering in September, when most other Cape *Oxalis* species start going dormant.



*Oxalis minuta* found growing in the lawn in front of the Education Building on the Stellenbosch University campus. Photo: Don Kirkwood

Frikkie also stumbled across a rare little species hidden in plain sight. *Oxalis minuta* was known to occur in both the Jan Marais and Duthie Reserves in Stellenbosch, but has not been observed in either for years. All of the other known (few) populations of this minute species have dwindled over the years, and they are all heavily degraded and invaded. So, we were delighted when Frikkie noticed a few small white flowers popping up on the lawn in front of the Stellenbosch University Education Building. Closer inspection confirmed them to be *Oxalis minuta*. With the help of Dr Don Kirkwood, curator of the Stellenbosch University Botanical Garden, we moved this valuable population into cultivation as part of the *Oxalis* living collection, thus ensuring that we maximize on preserving as much genetic diversity as possible – Prof Léanne Dreyer

**MANAGING A MARINE INVADER - A FIRST FOR AFRICA**

Marine invasive species can have negative effects on native biodiversity and detrimental socioeconomic impacts. One such species is the European shore crab *Carcinus maenas*. Invasive in many regions of the world, the crab was first discovered in South Africa in the early 1980s.

PhD student Clova Mabin, under the guidance of Profs Tammy Robinson and John Wilson investigated this notorious invader along the Cape Peninsula. As part of this study a trial management programme was undertaken with the aim of informing a national management strategy for the crab. This work saw the employment of more than 15 young people who deployed baited traps to catch and remove crabs from Hout Bay harbour over the period of a year. In this first attempt to manage a marine invader in Africa, 36 244 invasive crabs were removed. Despite this, the crab could not be extirpated. This study highlighted that administrative and logistical constraints need to be considered alongside the biology of the target species when planning management interventions for invasive taxa. Ultimately, it was found that cost of attempting nationwide eradication is prohibitive. These results align with calls to focus on the prevention of marine invasions rather than their management once species have established – Prof Tammy Robinson-Smythe



The alien shore crab *Carcinus maenas*. Photo: Tammy Robinson-Smythe.

**FRAGMENTED FOREST HABITATS CAN IMPACT THE CONSERVATION OF SOME SPECIES**

In 2020, Theo Busschau who studied under the supervision of Prof Savel Daniels, was awarded the Junior Captain Scott's medal for the best MSc in Zoology in South Africa. For his MSc he examined the comparative phylogeography of three codistributed reptile species along the Indian Ocean Coastal Belt forests of the Eastern Cape and KwaZulu-Natal provinces. Widespread genetic differentiation was observed in both the Pondoland flat gecko *Afroedura podolia* and the forest thread snake *Leptotyphlops sylvicolus*, while shallow divergence was observed in the Natal Black snake, *Macrelaps microlepidotus*. To date he has published two first author papers from his MSc research in *Molecular Phylogenetics and Evolution* and *Journal of Zoological Systematics and Evolutionary Research*. Currently he is working on a third manuscript that combines five DNA sequence data sets from five reptile species to explore the factors causal to phylogeographic patterning in the Maputaland-Pondoland-Albany biodiversity hotspot – Prof Savel Daniels



The three codistributed reptile species that Theo Busschau studied. Photos: Theo Busschau

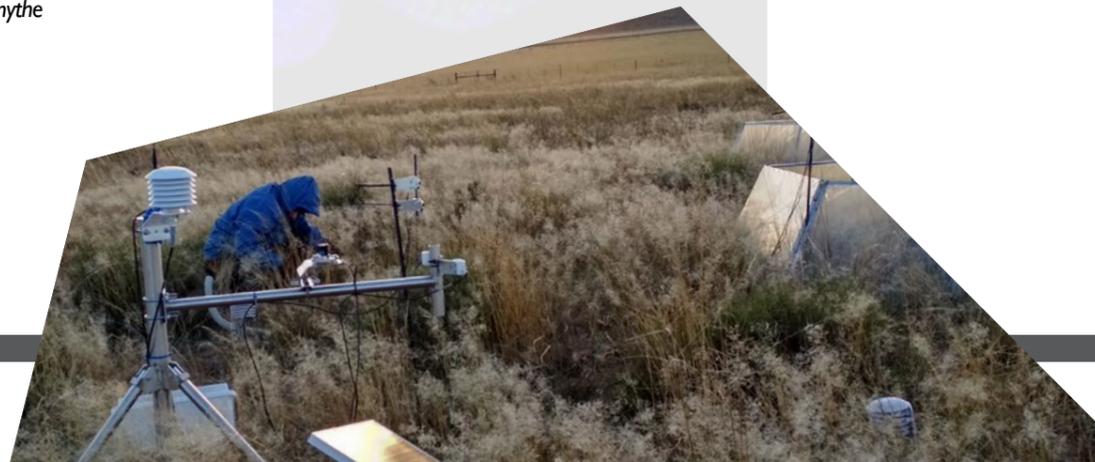
**COMPREHENSIVE REVIEW OF BIOLOGICAL INVASIONS**

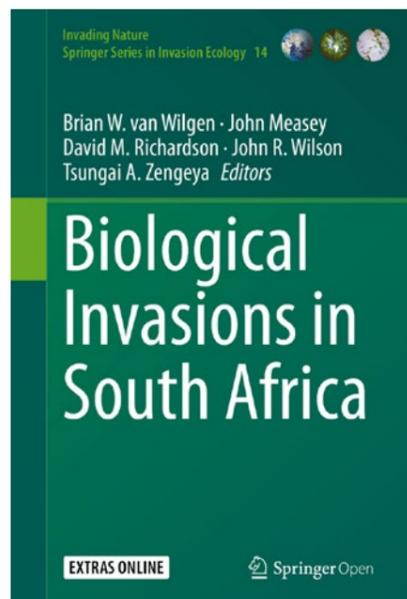
In 2020, researchers at the Centre for Invasion Biology published a landmark volume that covers all aspects of the ecology and management of biological invasions in South Africa. Biological invasion involves foreign (“alien”) species that establish in new environments and spread across the landscape, often causing substantial harm. Biological invasions are one of the major components of global change, and they have large impacts on biodiversity and ecosystem composition, structure and functioning. Consequently, governments spend substantial amounts of money in attempts to manage these invasions. This volume presents a comprehensive and encyclopaedic account of all aspects of biological invasions in South Africa, where research has been conducted over more than three decades, and where bold initiatives have been implemented in attempts to control invasions and to reduce their ecological, economic and social effects.

It covers a broad range of themes, including history, policy development and implementation, the status of invasions of animals and plants in terrestrial, marine and freshwater environments, the development of a robust ecological theory around biological invasions, the effectiveness of management interventions, and scenarios for the future.

The South African situation stands out because of the remarkable diversity of the country, and the wide range of problems encountered in its varied ecosystems, which has resulted in a disproportionate investment into both research and management. The South African experience holds many lessons for other parts of the world, and this book should be of immense value to researchers, students, managers, and policy-makers who deal with biological invasions and ecosystem management and conservation in most other regions.

The production of the book was led by Prof Brian van Wilgen of the CIB, assisted by a team of four editors. The resultant book of almost 1000 printed pages contains 31 chapters compiled by 104 contributing authors from a wide range of institutions in South Africa and beyond. It provides a rare example of a comprehensive account of an important topic from a country with a great deal of research and management experience, and addresses the vital connections between ecological theory, policy development and the implementation of management interventions. According to a recent review, the book sets a new standard in the dissemination of information on biological invasions, not only through its comprehensiveness but also through its philosophy of open access publication that allows readers to download the book or any of its constituent chapters free of charge. In the four months after publication in March 2020, the individual chapters were downloaded more than 6000 times each, which reflects the widespread global interest in this topic. – Prof Brian van Wilgen

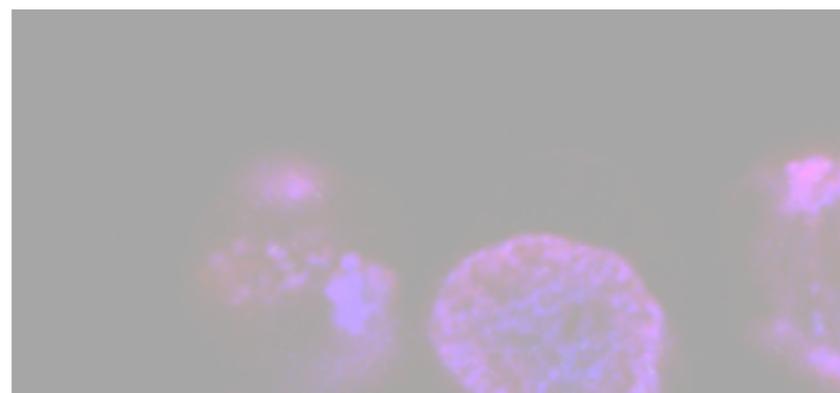




Invasive alien pine trees in the fynbos water catchments of the Western Cape. Photo: Brian van Wilgen

### TRACKING TRENDS IN GLOBAL WILDLIFE ABUNDANCE

**Prof Guy Midgley** from Stellenbosch University is one of 125 specialists from around the world who have contributed to the World Wildlife Fund's (WWF) *Living Planet Report 2020*. The *Living Planet Report 2020* presents a comprehensive overview of the state of our natural world through the Living Planet Index. This index, provided by the Zoological Society of London, has been tracking trends in global wildlife abundance since



1970. According to a media release issued by WWF, the Living Planet Index shows that there has been a 68% decline in global vertebrate species populations between 1970 and 2016, mainly caused by environmental destruction and the use and trade of wildlife.

### THE SECOND AFRICAN BIOACOUSTICS COMMUNITY ONLINE CONFERENCE

In a time where in-person conferences were being cancelled due to the global COVID-19 crisis, 2020 saw the second African Bioacoustics Community conference push forward with a completely virtual conference, moving all presentations to an online space to keep true to the spirit of promoting bioacoustics research and networking on the African continent. The conference was organised by **Dr Tess Gridley**, a postdoctoral fellow in Botany and Zoology and the co-director of Sea Search, together with **Dr Simon Elwen**, an extraordinary appointment in the Department of Botany and Zoology, in association with Stellenbosch University. It was even bigger and better than the previous conference, with the total number of attendees growing from 130 to 211; the total number of presenters in 2020 was 97. With funding received from sponsors, financial support was provided to 24 students, both presenters and non-presenters, to attend the conference. Many of these sponsored students were from African countries and would not otherwise have been able to afford the conference registration fees. Along with eight great plenary talks, standard and speed presentations as well as posters, two special sessions (Basics to bioacoustics and Hearing of Harms) were also hosted with great success. – *Dr Tess Gridley*

## ACADEMIC AFFAIRS

### STUDENT INFORMATION 2020

• Honours students	15
• MSc students	35
• PhD students	35
• Postdocs	28

### ONLINE BIOINFORMATICS HONOURS COURSE DEVELOPED FROM BIOLOGY 124 CONTENT

The Department of Botany and Zoology is responsible for the three first-year Biology service courses – Biology 124, 144 and 154. These modules are regularly evaluated and adapted since they serve as basis for programmes in Biological Science and AgriScience. In 2019, the department and specifically **Dr Marnel Mouton** took on a further venture – to develop Biology 124 into a Mode 2 delivery module in collaboration with the Centre for Learning Technologies, mainly for the Bioinformatics honours degree, but also possibly for undergraduate students in future. Dr Mouton obtained a University Capacity Development Grant that was used to assist the lecturers involved to create new material for this online course. In the second half of 2020, Dr Mouton worked with postdoctoral fellow Dr Wendy Stone to integrate the new course material into a cohesive and comprehensive online course for Introductory Biology. The module includes most theory from Biology 124 – Biochemistry, Cytology, Genetics and Evolution, as well as student-orientated active learning components to enhance learning and engagement for the honours students. This new Bioinformatics honours module was launched in 2021 and will run fulltime over a two-week period.

Dr Marnel Mouton was also asked to coordinate the compilation of a Biology section for the Mobilex multilingual subject-specific online dictionary developed by Stellenbosch University. Prof Conrad Matthee, Prof Leanne Dreyer, Prof Tammy Robinson and Dr Marnel Mouton contributed about 350 Biology terms with definitions in both Afrikaans and English to this dictionary. One of Botany and Zoology's PhD students, Tandokazi Magangana, then translated all these definitions into isiXhosa for the dictionary. We believe that this online resource will make a significant contribution to learning and teaching in Biology in future.

### BIOEXCEL TUTOR SUPPORT PROGRAMME MOVES ONLINE

**Dr Marnel Mouton** has been the coordinator of the BioExcel Tutor Support Programme since 2014, with Dr Janneke Aylward playing a crucial role in the day to day running of the programme. This flagship programme has been developed over years and contributes significantly to the throughput rate of first-year Biology students in Biology 124 and 154. Each year, feedback from the students and tutors are used to shape the content and delivery of the following cycle, thereby improving the offering with each cycle. During 2020, the entire programme had to be moved to the online space – a significant challenge over a very short time period. The team and tutors worked extremely hard to transform the face-to-face learning activities to an engaging online form. Students were supported on a weekly basis and encouraged via email and WhatsApp by this dedicated team of tutors. This new online offering was received very positively by the students, to the extent where we expect to keep a substantial number of sessions online in future. – *Dr Marnel Mouton*

### ONLINE ONBOARDING PROGRAMME FOR FIRST-YEAR STUDENTS

In 2020, Stellenbosch University realised that the 2021 first-year student cohort may be differently prepared than in previous years. **Drs Marnel Mouton** and **Ilse-Rootman-Le Grange** were tasked by the Faculty of Science to be part of the university's team to develop a generic programme for all new first-year students, but also, a separate more specific programme for the Faculty of Science.

Together, they compiled a comprehensive new SUNLearn course – The 2021 Onboarding Programme for First-year Students. This programme is a colourful interactive display of the people and activities in the faculty. It introduces the newcomers to the most important role-players in the faculty via information, photos and videos. It contains the most relevant information about the various programmes in Science, with videos that were made of each programme coordinator explaining their programme in an appropriate and interesting setting. There is also a section where a variety

of FAQs are addressed in a colourful manner. The programme was launched in February 2021 to prepare the new students for their studies at Maties – *Dr Marnel Mouton*

### ONLINE INTRODUCTORY META-ANALYSIS MODULE DEVELOPED

During 2020 the lockdown severely impacted the research component of the BScHons class. Traditionally, research projects are hands-on projects but with COVID-19 lockdown regulations, many students had to formulate new research projects in the online environment. This saw many students turning to projects requiring meta-analysis of already existing data sets. **Prof Tammy Robinson-Smythe** promptly developed an online introductory meta-analysis module for all honours students, which allowed the honours class of 2020 to complete their degree in time with a solid research component.

### AWARDS TO STAFF AND STUDENTS

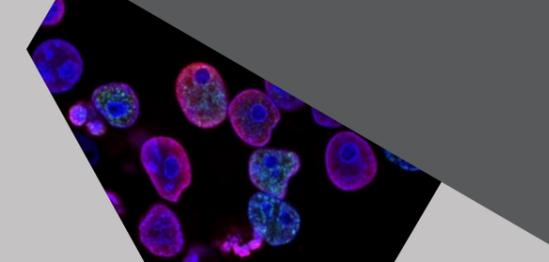
**Prof Wendy Foden** received The British Ecological Society's Marsh award for climate change research. She is a world-leading researcher in climate change vulnerability assessments of threatened species. The award will be handed over in 2021.

**Prof Conrad Matthee** and his team won the NSTF-Lewis Foundation Green Economy Award for their invention of the first eco-friendly shark barrier, the SharkSafe Barrier™.

**Dr James Baxter-Gilbert**, a postdoctoral fellow in the Centre for Invasion Biology, received a prestigious Vice-Rector's Postdoctoral Fellow Award for Exceptional Achievement for 2020.

**Prof Dave Richardson** was recognised as a true pioneer in his field over the last decade, producing multiple highly-cited papers that rank in the top 1% by citations for field and year in the Web of Science™. He was the only Stellenbosch University researcher to make the 2020 list.

**Theo Busschau**, a former MSc student of Prof Savel Daniels, was awarded the Junior Captain Scott Memorial Medal.



This medal is awarded to the best zoology or botany MSc thesis at a South African university by the South African Academy of Science and Art.

**Ria Olivier**, the Principal Investigator of the Antarctic Legacy of South Africa Programme, was awarded the 2020 Association of Polar Early Career Scientists (APECS) Mentorship award.

**Emeritus Profs Koot and Sophie Reinecke** received the ATKV-SA Akademieprys for 2020 for the best Afrikaans published article in 2018 (one of only two in the Biological Sciences).

**Emeritus Prof Dan Baird** was appointed Editor-in-Chief, together with Prof Mike Elliott (Hull University, UK) to edit the second edition of the *Treatise on Estuarine and Coastal Science*, published by Elsevier.

### SERVICE TO THE SCIENTIFIC COMMUNITY

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

**Prof Mike Cherry** serves on the steering committee of the Centre of Excellence at the Percy FitzPatrick Institute, and is an 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 for *Molecular Phylogenetics and Evolution* and the *African Journal of Marine Science*, and serves on the editorial board of *Koedoe*.

**Prof John Measey** is academic editor of *PeerJ* and associate editor of *Salamandra*, *Bioinvasions 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 sixth 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** is associate editor of *Aquatic Invasions* and *Bioinvasion Records*.

**Prof Dave Richardson** is associate editor of *Forest Ecosystems* and *Neobiota*, editorial advisory board member of *Frontiers of Biogeography* and *AoB PLANTS*, and 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 v/d Heyden** is associate editor for *Frontiers in Marine Science*, *Frontiers for Young Minds*, *Estuarine, Coastal and Shelf Science*.

**Prof Brian van Wilgen** is lead editor on a 1000 printed-pages book, entitled "Biological Invasions in South Africa" published in 2020.

**Prof John Wilson** is associate editor of *Neobiota*.

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

## SOCIAL IMPACT

### POLYCHAETE WORMS AS BAIT

For International Polychaete Day on 1 July 2020, **Prof Carol Simon** created a poster on bait species that South African anglers use. The exercise combined two of her passions: photography, and polychaetes, a group of about 8000 species of bristle worms which include a whole host of marine types. The poster was circulated via the twitter handle @SimonPlyLabSA where it was seen by 4,199 users, with 328 users engaging with the content. This forms part of an ongoing study investigating the taxonomy of polychaete worms used as bait in the region.



### IMBOVANE OUTREACH PROJECT

limbovane is a **science education programme** that works with Grade 10 learners at urban and rural secondary schools in the Western Cape. The project provides curricular support to learners and educators through their sampling of ant diversity around their school grounds and in nearby nature reserves while it raises awareness of science as an interesting and attractive career among learners.

In 2020, the limbovane project team interacted with 293 learners between January and March through school-based activities. During these activities, the project team introduced the learners to biodiversity theory as well as the practical task of collecting ant species in a scientific manner.

In addition to its school-based activities, limbovane hosted an information booth at the annual Western Cape Education Department (WCED) Biodiversity Careers Expo in the Karoo Desert National Botanical Garden on 5 March 2020. Learners visiting the limbovane exhibit were introduced to a variety of careers that are offered in biological sciences, the subjects needed and entry requirements.

At the end of March the national lockdown was declared and project

activities had to be suspended. Efforts to manage the spread of Covid-19 have had severe impacts on the schooling system and after consulting with the Western Cape Education Department (WCED), it became clear that the project team will not have access to learners for the rest of the 2020 school year. In response to this, the limbovane team set up alternative activities to support their educators and learners. These were (1) online lessons based on the project's annual school-based activities for the educators; (2) a virtual laboratory tour of the limbovane research laboratory; (3) live classroom lessons to selected schools through the Microsoft Teams online platform.

In October 2020, the limbovane project team set off to the Karoo National Park, where the team trained a group of 12 Junior Rangers on ant diversity. Geared with their 'pooters', and sampling equipment, the group scrambled through succulents in search of ant species. The day ended with close observations of ants under the microscope during which the group were exposed to ant morphology and the scientific naming of ants.

limbovane's efforts to deliver hands-on biodiversity education to the youth also received a welcome boost in 2020, thanks to a generous donation from the Mapula Trust.

Ant data that was collected by limbovane learners and educators on their school grounds between 2006 and 2014 contributed to another scientific paper. The paper, titled "Realised rather than fundamental thermal niches predict site occupancy: Implications for climate change forecasting", was published in the *Journal of Animal Ecology*. limbovane contributed to a chapter on science education in the first open access encyclopaedic book on biological invasions in South Africa, titled "Education, Training and Capacity-building in the Field of Biological Invasions in South Africa".



Prior to lockdown, limbovane trained learners on the value of biodiversity. Here learners from Gerrit du Plessis Secondary School (Riversdal), Riviersonderend High School (Riviersonderend) and Swartberg Secondary School (Caledon) are collecting ant species in their school grounds in March 2020. Photos: Doret du Plessis

## COLLABORATION

### Australia

Macquarie University  
Monash University  
University of Sydney

### Belgium

Ghent University

### Canada

McGill University  
McMaster University Hamilton  
University of Toronto

### Chile

Universidad de Austral  
Universidad de la Frontera  
Universidad de Concepción

### France

Museum National D'Histoire Naturelle  
University of Montpellier

### Germany

University of Bayreuth  
University of Frankfurt  
Zoologisches Forschungsmuseum  
Alexander Koenig

### Japan

University of Tohoku  
Iwate University

### 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  
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 Hawaii, USA  
University of Hong Kong  
Universidad Nacional del Litoral Santa Fe, Argentina.  
Universidad Pablo de Olavida, Spain  
University of Vienna, Austria  
Wageningen University, The Netherlands

## FUNDING

Belgium Directorate-general Development Cooperation  
Centre for Agriculture and Bioscience International (CABI)  
Council for Scientific and Industrial Research (CSIR)  
Escom Annual Koeberg Monitoring

Forestry and Agricultural Biotechnology Institute  
 Grootbos Foundation  
 Jan Marais National Fund  
 National Research Foundation  
 Royal Museum of Central Africa  
 SA Berry Producers  
 South African National Biodiversity Institute  
 Stellenbosch University  
 Technology Innovation Agency  
 University East Anglia  
 Wild Bird Trust

### STAFF MATTERS

**Profs Dave Richardson and Guy Midgley** had the title of Distinguished Professor conferred in recognition of having reached the pinnacle of achievement in their university careers. Both Dave and Guy will be appointed to this position for five years. Prof Richardson is the Director of the DSI-NRF Centre of Excellence for Invasion Biology and has authored and co-authored over 450 journal papers and book chapters and recently received the Kwame Nkrumah Award for Scientific Excellence from the African Union. Prof Midgley is a leading expert in the field of biodiversity and global change science and was recently awarded the prestigious Humboldt Research Award from the Alexander von Humboldt Foundation in Germany.

**Ms Zaynab Shaik** was appointed as a junior lecturer through the n-Gap initiative and **Mr Benjamin Petersen** was appointed as a technical assistant in 2020.

**Profs Bruce Anderson** and **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.

### 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 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
	Emeritus Prof D Baird	Marine ecology
	Emeritus Prof B van Wilgen	Biological invasions and conservation
	Extraordinary Prof J Wilson	Biological invasions and conservation
	Extraordin. Prof WJ Przybylowicz	Applications of nuclear microprobes in biology
	Established Researchers	Prof S Clusella-Trullas
Prof LL Dreyer		Evolution of Cape Flora
Prof NP Makunga		Medicinal plant bio technology
Prof TB Robinson		Drivers, patterns and impacts of marine invasions
Prof 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
Prof J Measey (CIB)		The conservation and ecology of invasive species
Extraordinary Prof L Foxcroft		Invasion ecology
Extraord Prof JM Mesjasz-Przybylowicz		Plant ecophysiology

### STAFF LIST (AS AT THE END OF 2020)

#### 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  
 Dr VR Rambau  
 Prof DM Richardson  
 Prof TB Robinson  
 Dr Z Shaik (newly appointed n-Gap position)  
 Prof CA Simon  
 Prof AJ Valentine  
 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 Appointments:

Prof W Przybylowicz  
 Prof J Przybylowicz  
 Prof W Foden  
 Prof L Foxcroft  
 Prof JR Wilson  
 Dr Elwin Simon

#### 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  
 Prof H Van Wyk

#### Support staff:

Ms J Basson  
 Ms F Gordon  
 Ms S Jacobs  
 Ms S Johnson-Abrahams  
 Ms DJD Julies  
 Ms J Hutton  
 Ms MJ Mathese  
 Ms AC Nel  
 Mr B Petersen (newly appointed 2020)

Mr R Robertson  
 Ms MP Sauerman  
 Mr N Solomons  
 Mr JP Williams  
 Mr H Witbooi

#### Support staff: Centre of Excellence for Invasion Biology:

Mr E Basson  
 Ms K Coombe-Davis  
 Dr S Davies  
 D du Plessis  
 Ms S Kritzinger-Klopper  
 Ms J Lategan  
 Dr E Marais  
 Ms C Momberg  
 Ms L Msomi  
 Ms E Nortjé  
 Ms M van der Vyver

#### Postdoctoral fellows:

Dr A Alvarez Aguilar  
 Dr S Andreotti  
 Dr WJ Augustyn  
 Dr JH Baxter-Gilbert  
 Dr H Beckett  
 Dr A Datta  
 Dr R Garcia  
 Dr T Gridley  
 Dr DT Guzha  
 Dr H Hirsch  
 Dr JA Kara  
 Dr JH Keet  
 Dr N Kruger  
 Dr B Loedolff  
 Dr TG Loureiro  
 Dr M Mairal Pisa  
 Dr NA Masondo  
 Dr A Melotto  
 Dr IA Minnaar  
 Dr C Minnaar  
 Dr A Ndhlovu  
 DR MM Nsikani  
 Dr NL Phair  
 Dr DJ Phair  
 Dr J Riley  
 Dr N Stevens  
 Dr L Van Der Mescht  
 Dr J Zeyl

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# DEPARTMENT OF CHEMISTRY AND POLYMER SCIENCE

## RESEARCH INTERESTS

Organic and medicinal chemistry  
Inorganic and organometallic chemistry  
Analytical chemistry  
Polymer science  
Materials technology (Performance properties of functional textiles)  
Physical and computational chemistry  
Supramolecular and materials chemistry  
Chemistry education  
Nanotechnology

## RESEARCH HIGHLIGHTS

### POLY(STYRENE-CO-MALEIC ANHYDRIDE)

Since several years, we are collaborating with researchers in the field of membrane proteins (MPs) on the use of SMA<sub>nh</sub> derivatives for the isolation of fully folded and functional MPs. One of these collaborations is with Prof JA Killian from Utrecht University in the Netherlands who specialises strongly on the mechanism of nanodisc formation when a phospholipid membrane is exposed to a hydrolysed derivative of SMA<sub>nh</sub> (SMA). The gold standard in this field is a 2:1 styrene:malesic acid copolymer made via conventional radical polymerisation. In order to study the SMA chain length dependence of the nanodisc formation, we developed an iterative process for the synthesis of a non-alternating SMA<sub>nh</sub> via Reversible Addition Fragmentation Chain Transfer (RAFT) mediated polymerisation. Via this rather labour-intensive method, we were able to synthesise SMA<sub>nh</sub> copolymers of varying chain length. After hydrolysis, the SMA copolymers were used to study interactions with phospholipid membranes. This work was published in a 2020 contribution in *Biomacromolecules*.

In collaboration with a former colleague from Eindhoven University of Technology, Dr JPA (Hans) Heuts, Prof Bert Klumperman wrote an invited contribution to celebrate Staudinger's

“On Polymerization”. In the contribution, they mathematically describe the relationship between copolymer composition and overall monomer conversion in a continuous stirred tank reactor (CSTR) for the copolymerisation of styrene and maleic anhydride. This copolymerisation proceeds according to a restricted penultimate unit model, where maleic anhydride doesn't homopropagate. With this restriction, it turns out that there is a straightforward analytical expression that describes the mentioned relation between copolymer composition and conversion. Experimental data from CSTR experiments of SMA<sub>nh</sub> syntheses at temperatures ranging from 90 – 160°C were used to corroborate the approach.

Alternating amphiphilic hetero-arm molecular brushes were synthesised using chemistry that is strongly related to SMA<sub>nh</sub> synthesis. Styrene was para-substituted with poly(ethylene oxide) chains of varying degree of polymerization, and MA<sub>nh</sub> was converted into N-(n-alkyl) maleimides with varying alkyl chain length. The alternating copolymerisation of the two classes of monomers led to a library of molecular brushes with varying side-chain length. In collaboration with Prof Alejandro J Müller from the University of the Basque Country, Spain, we studied the complex crystallisation behaviour of the molecular brushes. The results of this study were published in a 2020 contribution to *Macromolecules*. – Prof Bert Klumperman

### POLY(N-VINYLPYRROLIDONE)

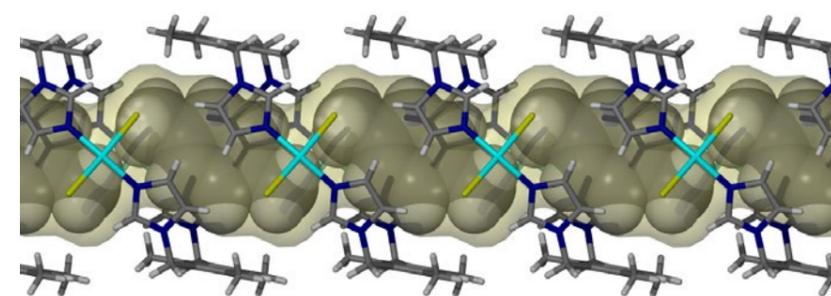
We have conducted several studies on the use of RAFT-made Poly(N-vinylpyrrolidone (PVP) in drug delivery systems. In 2020 we have published two of those studies that were both directed towards the delivery of antimalarial drugs. The first study was in collaboration with Prof Marina Rautenbach from the Department of Biochemistry, Stellenbosch University, and Prof Lyn-Marie Birkholtz from the University of Pretoria, and focused on the delivery of tyrocidine. Tyrocidine is a known antimalarial drug with strong membrane disruptive properties. Its main drawback for use as an antimalarial drug is its lack of specificity, i.e. systemic use of tyrocidine would lead to high levels of haemolysis. In our study, we conjugated a single PVP chain to every tyrocidine via a hydrolytically labile link. The amphiphilic character of the tyrocidine-PVP conjugate makes it self-assemble into micelles, which leads to stealth behaviour of the tyrocidine and therefore strongly reduced exposure of erythrocytes to the haemolytic peptide. The micelles were sparsely decorated with a malaria-specific targeting ligand. The overall outcome of in vitro experiments was an increase in specificity, although not quite to the anticipated level. This work was published in a 2020 contribution to *Biomacromolecules*.

The second study entailed a new delivery system based on PVP and a degradable polyester. The polyester was designed in such a way that hydroxy-functional drugs could be conjugated to it, again

via a hydrolysable link. An important difference between the tyrocidine study and this work is that here, multiple drug molecules could be attached per polymer chain. In collaboration with Prof Birkholtz, the system was tested with the drug combination artemether and lumefantrine. Release kinetics and preliminary efficacy data were published in a contribution to *ACS Biomaterials Science & Engineering*. – Prof Bert Klumperman

### SEPARATION OF XYLENES

The three isomers of xylene (ortho-, meta- and para-xylene) are extracted during the refinement of crude oil. They are precursors of several commercially important materials such as polymer fibres, films, plasticisers, resins, etc. However, the isomers first need to be separated from one another, and this is generally achieved using the energy-intensive process of distillation. Transiently porous crystals composed of dinuclear metallocycles were studied by Prof Len Barbour's research group with a view to discovering more efficient ways of separating commodity chemicals. They showed that this material absorbs para-xylene from a mixture of xylenes with record-setting selectivity. This work was published in the prestigious *Journal of the American Chemical Society*. – Prof Len Barbour



Para-xylene molecules encapsulated within the channels formed by stacked metallocycles. Image: Len Barbour

### DEVELOPMENT AND USE OF AN ENVIRONMENTAL GAS CELL FOR CRYSTALLOGRAPHY UNDER GAS PRESSURE

An environmental gas cell, developed in Prof Len Barbour's laboratory, was used by researchers at Georgetown and McGill universities to investigate the microporosity of a guanidinium organodisulfonate framework material.

The gas cell allows for structural determination of gas-loaded materials by means of X-ray crystallography. This collaborative work was published in the high-impact journal *Angewandte Chemie, International Edition*. – Prof Len Barbour

### PRESSURE-GRADIENT DIFFERENTIAL SCANNING CALORIMETRY

Thanks to generous funding from Stellenbosch University and the National Research Foundation, the Barbour group developed the new technique of pressure-ramped differential scanning calorimetry. This technique allows the direct measurement of heats of adsorption and desorption for gas uptake and release by porous materials. This method was shown to be superior (in both ease of use and accuracy) to the conventional indirect isosteric method, which relies on assumptions that generally do not apply at high pressures. This work was published as two separate articles in *ChemSusChem*. – Prof Len Barbour

### SOFTWARE FOR X-RAY CRYSTALLOGRAPHY

Prof Barbour made significant updates to his computer program X-Seed, which is widely used around the world by

X-ray crystallographers. The updates were described in the *Journal of Applied Crystallography*. – Prof Len Barbour

## RESEARCH ACTIVITIES

Prof Albena Lederer presented an invited talk at the International Symposium on Field- and Flow-Based Separations 2020 at the University of Vienna, Austria.

Dr Rehana Malgas-Enus gave an invited oral presentation on “Surface engineering of metal nanoparticles for targeted application” at the 4th International Symposium on Nanoparticles/Nanomaterials and Applications in January 2020. On 29 February 2020 she presented a keynote lecture entitled “Leading by example: pedagogical leadership from an academic perspective” at the Metropole South Education District, HOD Teachers Conference. She was also invited to speak at the Early Career Academic Development (ECAD) Meeting on 25 June 2020; her online presentation was entitled “The journey from Mentee to Mentor”.

Prof André de Villiers presented an invited keynote lecture at the 16th International Symposium

on Hyphenated Techniques in Chromatography (HTC-16) held on January 29-31 2020 in Ghent, Belgium.

**Prof Bert Klumperman** participated in an online workshop of the SMALP Community in June 2020, where he presented research on the iterative process for preparing non-alternating SMA<sub>n</sub>h (also see Research Highlights).

**Prof Delia Haynes** presented an invited lecture at the 2020 African Light Source Workshop (AFLS2020), held online in November 2020.

**Prof Len Barbour** was invited to present a pre-symposium workshop on his X-Seed software for crystallography at the 2020 Bruker/MIT Symposium (Massachusetts Institute of Technology) in February 2020. This was followed by an invited lecture on structural flexibility in the solid state at the Symposium. In March 2020 he presented an invited lecture at McGill University in Montreal, Canada. He also presented an invited lecture at the Crystal Engineering and Emerging Materials Workshop of Ontario and Quebec (CEMWOQ 6.5), an online conference hosted in May 2020 at Concordia University in Montreal, Canada.

**Dr Leigh Loots** presented an invited lecture at the 2020 Bruker/MIT Symposium (Massachusetts Institute of Technology) in February 2020. In March 2020 she also presented an invited lecture at McGill University in Montreal, Canada.

## NEW RESEARCH EQUIPMENT AND FACILITIES

**Profs Barbour and Haynes** were awarded funding to purchase two Diamond Anvil Cells, which arrived shortly before lockdown started in early 2020. This specialised equipment will facilitate the determination of crystal structures under very high pressures (up to 50 GPa). This will allow us to investigate how flexible crystalline materials respond to pressure, with a particular focus on the compressibility properties of porous materials, including metal-organic frameworks, as well as the effect of high pressures on non-covalent interactions and polymorphism.

The tissue culture facility has been commissioned for **Dr Catherine Kaschula's** Bioassay lab. It comprises a laminar flow hood and incubator, a microscope, and a newly purchased Countess Cell Counter. This is the result of a collaboration with Prof Amanda Swart, emeritus professor of Biochemistry, who is supervising her current PhD-students and continuing her research in Dr Kaschula's lab. The equipment, including an ultra-low temperature (-80 °C) freezer and a liquid nitrogen cryostorage tank, will allow them to carry out tissue culture techniques.

In the course of 2020, we were successful in securing funding to a total amount of R27.5 million for the replacement of two NMR spectrometers (400 MHz and 600 MHz). The purchase and installation of the new spectrometers will take place in 2021.

## SERVICE TO THE SCIENTIFIC COMMUNITY

**Prof Peter Mallon** served as the President of the South African Chemical Institute (SACI). He also serves as a member of the International Union of Pure and Applied Chemistry (IUPAC) Division IV: Polymer, and has been elected as a permanent member of the Subcommittee on Polymer Terminology. Prof Mallon has also been appointed as a founding board member of the Commonwealth Chemical Federation of Commonwealth Chemistry Societies.

**Prof Catharine Esterhuysen** served as chair, **Prof Delia Haynes** as co-chair, **Dr Rehana Malgas-Enus** as treasurer and **Prof Jan Dillen** as a member of the organising committee of the 4th International Symposium on Halogen Bonding, held online from 2 to 5 November 2021.

**Prof Catharine Esterhuysen** was appointed as an Associate Editor of the *New Journal of Chemistry*, published by the Royal Society of Chemistry (RSC).

**Prof Len Barbour** was appointed as an Associate Editor of *Crystal Growth and Design*, which is published by the American Chemical Society (ACS). He also served on the Editorial Advisory Boards of *CrystEngComm* (an RSC journal) and *ACS Sustainable Chemistry and Engineering*. In 2020 he was appointed to the Editorial Advisory Board of *Chemistry of Materials* (an ACS journal).

As one of the co-directors of the SMALP Network, **Prof Bert Klumperman** initiated the idea of an Industry Club as a platform where producers of the amphiphilic copolymers and users of the SMALP technology could exchange ideas on the way forward for the technology. The Industry Club was launched in 2020 and is now having (virtual) meetings every three months. Prof Klumperman continued as an Associate Editor of *Macromolecules* (ACS) and Editor-in-Chief of the *Transactions of the Royal Society of South Africa*. He also served on the Council of the Royal Society of South Africa.

**Dr Margaret Blackie** and **Dr Carla Pretorius** serve on the committee for the International Conference on Chemistry Education, which will now be held in July 2022.

**Dr Margaret Blackie** continues to serve as treasurer for the Western Cape division of the South African Chemical Institute (SACI).

**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 the Stellenbosch Institute for Advanced Study (STIAS) in

Stellenbosch. He is also a member of the Editorial Advisory Boards of the *Journal of Chromatography*, *Analytical Chemistry*, *Chromatographia* and *LCCG*.

**Prof Willem van Otterlo** continues as Vice-President of SACI (2019-2021). He also served as one of two Alexander von Humboldt (AvH) Ambassador Scientists for South Africa, appointed from 2019 to 2022. In March 2020, he was invited onto the control board of the open-access journal, *Archives of Organic Chemistry* – Arkivoc. This open access journal has received the Gold Seal of the Directory of Open Access Journals and is hosted by the University of Florida, USA. Prof Van Otterlo also guest-edited a special regional issue of the journal entitled *Organic Chemistry in South Africa*, over two parts, which attracted 24 articles.

**Prof Albena Lederer** was a member of the Editorial Board of the *International Journal of Polymer Analysis and Characterization* (Taylor and Francis) and of *Materials* (MDPI). She is Vice-Chair of the Scientific Committee for the International Symposia on Field and Flow Fractionation and a member of the scientific committees of the International Symposium on Separation and Characterization of Natural and Synthetic Macromolecules (SCM-X, 2021, Amsterdam) and the International Symposium on Field- and Flow-based Separations (2020 Vienna, Austria).

**Prof Selwyn Mapolie** continues to serve as committee member of the Catalysis Society of South Africa (CATSA).

**Prof Delia Haynes** is the Chair of the Executive of the Steering Committee for the African Crystallographic Association (2019 – present), and an elected member of the Executive Committee of the European Crystallographic Association (2018 – present). She is also the regional editor for Africa for the International Union of Crystallography Newsletter

(2018 – present), and a member of the SACI Western Cape Committee (2014-present).

**Dr Rehana Malgas-Enus** serves as an editor for Springer *Nature Applied Sciences*. She also serves on the NRF Thuthuka review panel, as well as the SU Social Impact committee and the SU Transformation committee.

## COLLABORATION

### South Africa

Cape Peninsula University of Technology Drug Discovery and Development Centre (H3D), University of Cape Town Nelson Mandela University North West University Rhodes University University of Cape Town University of Johannesburg University of KwaZulu Natal University of Pretoria University of Venda

### Africa

University of Yaoundé, Cameroon

### International

### Australia

Queensland University of Technology, Griffith University

### Austria

University of Natural Resources and Life Sciences, Medical University of Vienna

### Belgium

Ghent University

### Canada

University of Waterloo, McGill University

### Czech Republic

Technical University of Liberec

### France

Université de Lorraine

### Germany

Leibniz-Institut für Polymerforschung Dresden, Albert Ludwig University of Freiburg

### India

Jawaharlal Nehru University

### Ireland

University of Limerick

### Netherlands

University of Amsterdam, Vrije University Amsterdam

### Poland

University of Warsaw Adam Mickiewicz University

### Portugal

NOVA University Lisbon

### Prague

University of Chemistry and Technology

### United Arab Emirates

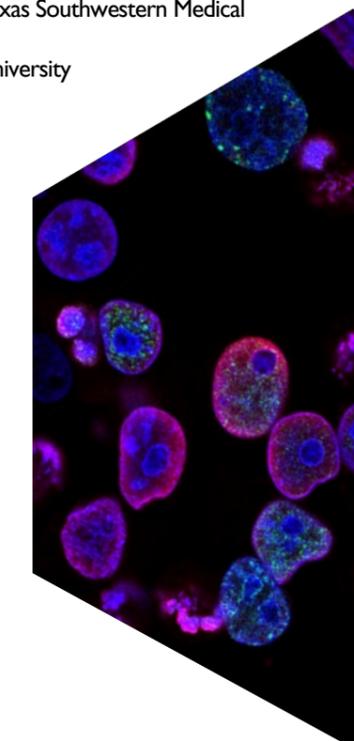
New York University Abu Dhabi

### United Kingdom

Lancaster University, National History Museum, University of Nottingham

### United States of America

Gustavus Adolphus College Virginia Polytechnic Institute and State University National Cancer Institute Georgia Institute of Technology University of Texas Southwestern Medical Centre Georgetown University



## 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
Established researchers	Prof Gareth Arnott	inherently chiral calixarenes; asymmetric methodology
	Dr Margaret Blackie	organic chemistry
	Dr Katherine de Villiers	antimalarial agents
	Prof Jan Dillen	computational studies
	Prof Catharine Esterhuysen	intermolecular interactions
	Prof Ivan Green	small molecule syntheses for medicinal application
	Prof Delia Haynes	crystal engineering of non-metal containing materials
	Dr Robbie Luckay	ligand design for metal ion coordination in industrial and medical applications
	Prof Peter Mallon	complex polymer materials and polymer nano-composites
	Prof Selwyn Mapolie	homogeneous catalysis via dendrimeric complexes
Promising young researchers	Dr Helen Pfukwa	polymer characterisation
	Dr Rueben Pfukwa	living radical polymerisation

## ACADEMIC AFFAIRS

The Department of Chemistry and Polymer Science now offers Materials Technology as third stream in the BSc Chemistry degree (replacing Textile and Polymer Science). This stream trains graduates in all fundamental aspects of chemistry and polymer science, but will be specifically aimed at careers that focus either on the industrial production of materials relevant to the SA industry, or on technological innovation and materials engineering.

## AWARDS TO STAFF AND STUDENTS

**Prof LJ Barbour** received the Royal Society of South Africa's John FW Herschel Medal. This is the RSA's senior medal and is awarded to those who are outstanding in either a field of research that straddles disciplines or in more than one unrelated field.

**Dr MAL Blackie** received the SU Teaching Excellence Award in the category of Distinguished Teacher, as well as the South African Chemical Institute's Chemical Education Medal.

**Prof AJ de Villiers** received the HTC Award for the Most Innovative Presentation at the 16th International Symposium on Hyphenated Techniques in Chromatography and Separation Technology (HTC-16), Ghent, Belgium. Both Prof De Villiers and Prof H Pasch were listed on the 2020 Power List of the *Analytical Scientist*.

**Prof C Esterhuysen** was elected as a Fellow of the Royal Society of South Africa

**Dr R Malgas-Enus** was a finalist for the National Science and Technology Forum (NSTF)/South32 2019/2020 Communication Award.

**Prof SF Mapolie** was elected as a Fellow of the South African Chemical Institute.

**Dr P Chellan** received a Future Leaders-African Independent Research (FLAIR) Fellowship from the Royal Society and African Academy of Sciences to undertake research on metallo-drug discovery for malaria.

**Dr UL Muza** received the Marie Skłodowska-Curie grant from the European Union's Horizon 2020 Research and Innovation Programme for the project USOME at the Leibniz Institute for Polymer Research (IPF) Dresden, Germany. He will focus on advanced analysis of polymersome and exosome hybrids for potential application in therapeutics and diagnostics.

**Dr A Ndiropo** and **Dr HA Nkabyo** received the Vice-Rector's Postdoctoral Fellow Award for Exceptional Achievement for 2020.

**Michael-Phillip Smith** and **Lauren E Ball** were both awarded the prestigious Wilhelm Frank scholarship for their MSc and PhD studies, respectively.

**Ms J Lombard** was the recipient of the SACI Postgraduate after Award

**Ms D Ali** was a 2020 Awardee in the L'Oreal-UNESCO for Woman in Science Programme for Sub-Saharan Africa.

## STAFF MATTERS

**Prof A Lederer** was appointed as the new holder of the Sasol Chair in Analytical Polymer Science. **Dr R Pretorius** was appointed on a two year contract and **Mr JS Motshweni** in the new position as senior technical officer in the Polymer Building. **Prof JLM Dillen** retired at the end of 2020.

## SOCIAL IMPACT

**Dr Margaret Blackie** wrote a series of articles for Spotlight.Africa on Covid-19, and an opinion piece in the *Mail & Guardian* on the possibility of decolonising Science Education.

**Dr Rehana Malgas-Enus** received a sponsorship from the Stigting vir Bemagtiging deur Afrikaans (SBA) and the Het-Jan Marais Foundation for outreach activities. She also received a donation of 115 Smart Tabs, which is housed by the Social Impact Division, for use in outreach activities. In light of the COVID-19 pandemic, she also recently established LAB-M8. Due to high school learners being unable to do their practicals at school, the Grade 11 and Grade 12 chemistry experiments are recorded and combined with the SUNCOI practical workbooks. This means learners can watch the video, extract the data, and complete their practical reports. They are only shown the necessary glassware and techniques (e.g., how to use a burette, how to make a standard solution, etc), as well as results of the experiment. They are provided with the data for calculation of the results and then required to draw their own conclusions. This approach is conducive to learning and understanding.

The emergence of the Covid-19 pandemic resulted in an escalating demand for face masks and thus a pressing need for more information on the performance of the components in the so-called "cloth masks". **Mrs Adine Gericke** responded by providing a fabric testing service to industry in which the compliance of textile fabrics with regard to filtration efficiency and breathability within these requirements were evaluated. She was also part of the team that wrote and updated the South African Department of Trade, Industry and Competition's

guidelines for fabric masks, published online on 29 April 2020.

## FUNDING

DST/NRF SARChI Programme  
NRF National Equipment Programme  
NRF Thutuka Programme  
NRF Competitive Programme for Rated Researchers  
The European Union (M-ERA-NET Initiative)  
Sasol  
Stellenbosch University  
The Royal Society  
The African Academy of Sciences

## STAFF LIST

## Academic staff

## Research Chairs:

Prof LJ Barbour  
Prof L 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 / Lecturer:

Dr MAL Blackie  
Dr P Chellan  
Dr KA 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  
Dr R Pretorius

## Senior Researchers / Research associates / Fellows:

Dr NP Gule  
Dr R Pfulkwa  
Dr AGJ Tredoux

## Extraordinary professors:

Prof IR Green

Prof A Lederer  
Prof W Mackenroth

## Emeritus professors:

Prof BV Burger  
Prof HG Raubenheimer

## Support staff

## Administrative staff:

Mrs MMG Cooper  
Mr MK Dlodlu  
Dr M du Plessis  
Mr JG Goldie  
Mrs SG May

## Technical staff:

Mr EJ Lukhele  
Mr MG Marupula  
Mr MA Mclean  
Mr S Mohamed  
Mr JS Motshweni  
Mr A Nxopo  
Dr H Pfulkwa  
Mrs PJ Steyn  
Mr GR Willemse

## Assistants:

Ms F de Vries  
Ms D Isaacs  
Ms M Jones  
Mr CW Maart  
Ms Y Mgqala  
Ms NS Ntwana  
Ms CJ van Reenen  
Mr M Wakens  
Ms DC Wenn

## Post-doctoral fellows:

Dr I Barnard  
Dr D Berthold  
Dr PS Eselem Bungu  
Dr WAS Hadasha  
Dr A Hazra  
Dr S Jokonya  
Dr L Loots  
Dr A Ndiripo  
Dr HA Nkabyo  
Dr J October  
Dr S Sanyal  
Dr P Sikiti

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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  
Gold- and base-metal mineralisation  
Heavy mineral deposits  
Geometallurgy

## Environmental geochemistry

Trace-element and isotope geochemistry  
Marine geochemistry  
Hydrogeochemistry  
Hydrogeology  
Environmental geochemistry  
Isotope hydrology

## RESEARCH HIGHLIGHTS

## INVESTIGATING CLIMATE IMPACTS ON WHALES

Three South African universities are involved in a research project that aims to understand how changes in the ocean influence the recovery of humpback whale populations in the Southern Hemisphere.

During the previous century humpback whale populations were severely depleted by the modern whaling industry, with catches of over 220 000 individuals between 1904 and 1972 (from an existing population of around 140 000 prior to modern whaling). Since protection in the 1960s and 1970s, certain populations have started to recover.

The Whales and Climate Research Program was conceptualised by Prof Alakendra Roychoudhury, an environmental geochemist in the Department of Earth Sciences (SU), in collaboration with Professor Brendan Mackey, Director of the Griffith Climate Change Response Program at Griffith University in Australia. The research

team also includes Prof Ken Findlay, a whale expert from the Cape Peninsula University of Technology (CPUT), Associate Professor Marcello Vichi, an oceanographer from the University of Cape Town (UCT), and another four research institutions from South America.

The Southern Ocean is vastly unexplored, and there is an urgent need for both seasonal and long-term observations from this vast expanse of ocean. A lack of ground-truth data provides a skewed picture in climate models, creating uncertainties. Recent observations of fluxes in carbon dioxide, a major driver in climate change, show that the Southern Ocean is behaving quite differently from what researchers understand from climatology and satellite data.

Over the next six years multiple research cruises and field work is scheduled for the feeding and breeding grounds of target populations in Antarctica and the coastlines of Australia, Africa, and South America. The Whales and Climate Research Program will be hosted at

Griffith University. The humpback whale migration models and access to relevant project information are available at [www.whalesandclimate.org](http://www.whalesandclimate.org) - Prof Alakendra Roychoudhury

## FORMATION OF GOLD MINERALISATION IN THE KIRK RANGE, MALAWI

Dr Joshua Chisambi completed his PhD under supervision of Dr Bjorn von der Heyden. Dr Chisambi's PhD, which investigated the formation of gold mineralisation in the Kirk Range in Malawi, was sponsored by a World Bank grant to the University of Malawi for skills development. The research has resulted in the first dedicated scientific descriptions of these gold showings, published in two peer-reviewed publications thus far. Since graduation, he has returned to the Malawi Polytechnic, a constituent college of the University of Malawi, as a member of staff where he is actively employing his teaching and research skills to develop a new economic geology research hub. – Dr B von der Heyden



Dr Joshua Chisambi inspecting the equipment set up as part of a new economic geology research hub at the Malawi Polytechnic, a constituent college of the University of Malawi. Photo supplied

**CONCLUSION OF A RESEARCH PROGRAM FOCUSED ON GOLD MINERALISATION IN A REMOTE PART OF TANZANIA**

A 2016 National Research Foundation (NRF) Unrated Researcher grant provided financial backing to undertake research on gold mineralisation hosted in previously undescribed rocks of the Ubendian Belt in southwestern Tanzania. This research program ultimately developed into a PhD thesis for candidate Stephan Dunn who graduated in March 2021. The work has to date culminated in four scientific publications, which have attracted significant attention from industry. The area has recently been detailed as an exploration project by a company listed on the Australian Stock Exchange (ASX) - *Dr B von der Heyden*



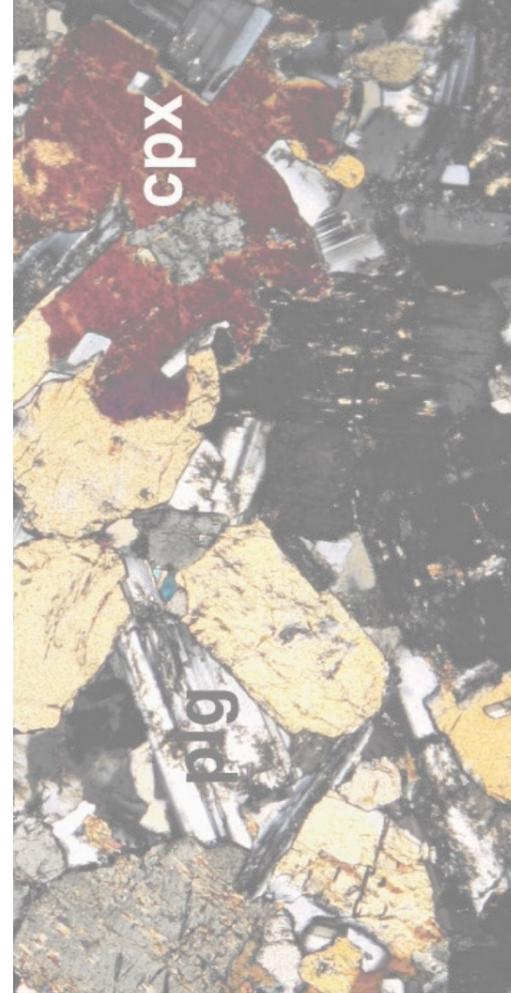
PhD-student Stephan Dunn undertaking field work in southwestern Tanzania. *Photo: B von der Heyden*

**A SYNCHROTRON FACILITY FOR AFRICA**

There is a strong push towards developing a synchrotron facility in Africa to promote competitiveness in the global research arena. Through publication outputs, committee involvements and conference organisation, Dr Bjorn von der Heyden is playing an active role in facilitating this initiative, and to ensure that the Earth Sciences are well represented during the planning and conceptual stages of building a scientific case to highlight the importance of having such a facility on the African continent.

**RESEARCHING MAFIC AND ULTRAMAFIC INTRUSIONS ACROSS SOUTHERN AND CENTRAL AFRICA**

The almost global lockdown during most of 2020 did not prevent progress to be made on research into mafic and ultramafic intrusions across southern and central Africa. MSc-candidate Mr Legran Plavy sampled a wide suite of rocks from two Ntem craton edges in the Republic of Congo, while Mr Patient Kananu spent most of the year sampling >200 mafic outcrops across the Bomu craton in the northern parts of the Democratic Republic of the Congo (DRC). Both candidates will continue studying these rocks for their MSc-projects at Stellenbosch University, in collaboration with local institutions in Brazzaville, Isiro, Bunia and Yaoundo in Cameroon. At Yaoundo University, another co-supervised PhD-student will target mafic and ultramafic intrusions of the Ntem craton from the north, and thereby eventually provide a much needed dyke swarm map for this craton, just as a preliminary dyke swarm map will also be made for the Bomu craton, the first of its kind. – *Dr M Klausen*



Earth Sciences research team in the Southern Ocean greet Delft Technical School class during an outreach project. *Photo: Dr S Fietz*



On the left, a 2020 field team in front of an outcrop near Zoulabouth, in the Sangha Province in the Republic of Congo, photographed on their journey to sample mafic to ultramafic outcrops on the Archean Ntem Craton. From left to right, their guide, two MSc students, Anga and Frank, from the Marien Ngouabi University in Brazzaville, and MSc-student Legran Plavy, who has just enrolled as an MSc-student at Stellenbosch University: *Photo: Mr Guellor*

On the right, A 2020 Barrick field team in the Democratic Republic of Congo, assisting MSc-student Patient Kananu from Stellenbosch University in his sampling of mafic to ultramafic outcrops across the Archean Bomu Craton (NE DRC). From left to right, Martin Kapinga (senior geologist), Dieumerci Karba and Wilfred Kami (both junior geologists), Patient Kananu (Stellenbosch University) and Jean Pierre Atafo (assistant geologist) at Barrick's Lanza fly camp with the Kibali River in the background. *Photo: Patient Kananu*

**RANGE OF NEW RESEARCH FROM THE RCRUST WORKING GROUP**

The Rcrust working group produced a range of new research including a recent publication on Miocene high-temperature leucogranite magmatism in the Himalayan orogeny published in the *GSA Bulletin*. Work continues on pressure and temperature constraints on the formation of the Adamello batholith in Northern Italy and ongoing publications in *Geophysical Research Letters* on topics of planetary science. This includes research on melt production and loss from Mars as well as recent work which suggests that the ocean underneath Europa's icesheets could have been formed by metamorphism of Europa's rocky core. This hypothesis amongst other work will be tested when the Europa Clipper mission flies past Europa later this decade. – *Dr Matthew Mayne*



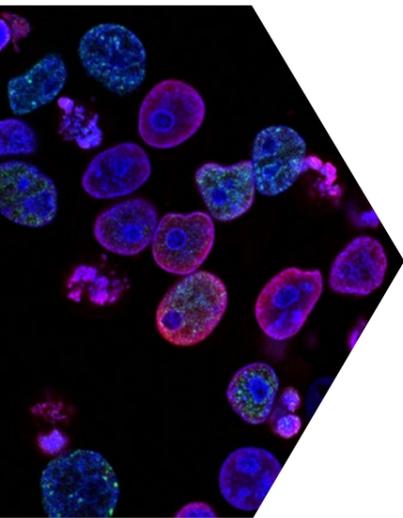
Dr Matthew Mayne observed geological formations during the Hutton Symposium 2019 in China where he met with collaborators, including Dr Gao Peng, to produce a *GSA Bulletin* paper on high temperature magmatism. *Photo: Matthew Mayne*

**NOVEL METHOD FOR SAMPLING OF COARSE GRAINED ROCKS**

A recent collaboration between the Council for Geoscience and Stellenbosch University saw a team of seven researchers conduct a geochemical sampling expedition in the Orange River Pegmatite Belt, Northern Cape, South Africa. The team hopes to produce a novel methodology for the sampling of coarse grained rocks such as pegmatites which have recently begun to see a lot of exploration potential due to the increased demand for rare earth elements and renewable energy associated minerals such as Lithium - *Dr M Mayne*



On the top, Stellenbosch University and Council for Geoscience research team at Uranoop Pegmatite in the Northern Cape, South Africa. On the bottom, Dr Bjorn von der Heyden observing the large grain size of the pegmatitic rocks which makes them notoriously difficult to sample, but also provides a unique deposit type of economic importance for the renewable energy and electronics sectors.



## RESEARCH ACTIVITIES

**Dr Susanne Fietz** attended the online international Goldschmidt conference on geochemistry and related subjects, organised by the Geochemical Society and the European Association of Geochemistry. She attended the online meeting of the GEOTRACES SSC as a member of the steering committee. Other online workshops attended are the AllAtlantic Forum, the SA-Norway bilateral workshop on polar research, and the SA-Norway bilateral workshop on marine plastic pollution.

Before the promulgation of the lockdown regulations, **Dr Martin Klausen** presented at the biannual Nordic Geological Winter Meeting, hosted by the University of Oslo, Norway. He presented his research on the volcanic Miyi Rift, in the late-Permian Emeishan Large Igneous Province, together with co-authors Allan Wilson, Gordon Chunnnett and Yong Yao.

On 19 October 2020 **Dr Matthew Mayne** gave an invited seminar presentation at the Jet Propulsion Laboratory of the California Institute of Technology in the United States as part of the Science Visitor and Colloquium Program where he introduced members of the planetary science community to the potential applications of the Stellenbosch University software tool Rcrust. The talk, entitled “The applications of open system phase equilibria modelling tools in planetary sciences”, received media coverage in *The Daily Maverick*.

**Dr Bjorn von der Heyden** was the lead organiser of the scientific committee for

the Geological Society of South Africa’s (GSSA) Geocongress 2020. Due to the lockdown regulations, the conference was postponed to 2021. He was a member of the organising committee for the third African Light Source Conference, which was presented virtually.

**International visits or visitors**  
MSc-student Hugo Dominquez-Carranza from the University of Lyon worked with **Prof Gary Stevens** from January to March 2020, before he was repatriated back to France on the last flight out of Cape Town before lockdown level 5 came into effect.

**Collaboration**  
**Dr B von der Heyden** collaborated with Brayden St Pierre from the Université du Québec on Au mineralisation in Tanzania. Other ongoing collaborations include a review of synchrotron use in the African Earth Sciences with Julien Benoit from the University of the Witwatersrand and Vincent Fernandez from the European Synchrotron Radiation Facility. Working with Peter Ravenscroft from Burgundy Mining, they are investigating kimberlite deposits using a novel cost filter.

**Dr Ryan Tucker** is part of an international team of researchers, funded by the National Science Foundation’s (NSF) Frontier Research in Earth Sciences (FRES) programme, working towards integrating the dynamic geologic, climatic and biotic systems of North America during the Early to Late Cretaceous transition. He is also involved with the

National Research Foundation’s (NRF) African Origins Platform (AOP), to investigate Mio-Pliocene marine mammals from southern Africa’s south-western Coast and their palaeoenvironments.

**Prof G Stevens** continued his significant collaboration with Jeff Moyen at the University of Saint Etienne, Cris Lana at the University of Ouro Preto, Dirk Frei at University of the Western Cape, and Katie Smart at the University of the Witwatersrand.

## SERVICE TO THE SCIENTIFIC COMMUNITY

During 2020, **Dr B von der Heyden** served on various committees, including the Mineralogical Society of South Africa (MINSAs), the South African National Committee for Scientific Committee on Oceanic Research (SCOR), and the African Light Source International Conferences organising committee.

**Dr Susanne Fietz** is editor of the journal *International Review of Hydrobiology*.

**Dr Ryan Tucker** has served on the auction committee of the Society of Vertebrate Paleontology. He currently holds a position on the editorial board of the journals *Frontiers in Ecology and Evolution and Earth Science*, and a review editor for *Paleontology and Earth Sciences*, part of the journals.

**Prof G Stevens** has served on the editorial board of the *Journal of*

*Metamorphic Geology*, and as a Specialist Assessor for the Australian Research Council.

**Prof Alex Kisters** was co-editor of a special issue of the *South African Journal of Geology* in honour of Prof Carl Anhaeusser and his contributions to South African Geology on the occasion of his 80th birthday.

## ACADEMIC AFFAIRS

The COVID-pandemic left its imprint on our teaching in more than one way. The first challenge to overcome was a smooth, almost flawless, transition from traditional in-class teaching to complete online offering during the first hard lockdown period. During this time the Department also took the opportunity to restructure its module offering and assessments from the traditional “examination assessment” to “flexible assessment”. The main difference is that the assessment is based on assignments, tests and practicals distributed and marked throughout the module, instead of being based on one, all-decisive exam at the end of a module. This has numerous advantages. Students can monitor their progress in individual modules, the final mark is a closer reflection of students’ understanding and performance throughout the year, and the anxieties around final exams are eliminated.

Despite the transition from in-class to online teaching, student pass rates remained remarkably similar compared to

previous and “normal” years. In fact, pass rates of some modules improved.

Despite the lockdown and the need for social distancing, the Department conducted its main field trips and mapping camps in the September recess and with great success. Field work was followed by a two-week in-class practical block for essential hands-on experiences such as mineralogy and microscope work or cross-section work and constructions in structural geology.

2020 saw a solid number of four MSc and five PhD students graduating during the March and December graduation ceremonies.

Despite the difficult organisational conditions associated with the ongoing Covid-pandemic, **Dr Bjorn von der Heyden** managed the safe running of the Honours students’ ten-day field school and mine visit. This field component is a crucial component of the Honours’ educational experiences since it provides them with a unique opportunity to understand how their university training and field of knowledge fits into the broader Southern African mineral resources sector. The tour ran between 15 – 24 November and the shortened tour meant that as much as possible had to be crammed into the 3 400 km round journey, mostly focussed on geology of the Western- and Northern Capes.



BScHons-student Nathi Mthethwa enjoys experiencing the stromatolites at the Pering MVT deposit, host to significant Zn-Pb mineralisation. Photo: Bjorn von der Heyden



The SU BScHons class of 2020 pose at their year-end function, with the theme ‘PPE’. Photo: Bjorn von der Heyden

Due to restrictions imposed by the global Covid-19 pandemic, university lectures had to be delivered online as with many other services. Since a large component of the Earth Sciences materials involve practical work such as rock identification, unique solutions needed to be found to provide online teaching that still provided the necessary training in practical skills. Lecturers such as **Dr Matthew Mayne** employed high quality web-cameras and lapel microphones, along with creative design of class activities.

Because of the strict lockdown regulations, the laboratories had to be shut down and a number of our postgraduate students had to change their research strategies, as they were not able to accomplish planned laboratory experiments and expeditions.

## AWARDS TO STAFF AND STUDENTS

**Dr B von der Heyden** was nominated for the Society of Economic Geologists (SEG) prestigious Lindgren Award.

**Dr Andrew Watson**, a postdoc of Prof Jodie Miller, was one of the Top 20 Postdoc Awardees of SU for 2020. He published six peer-reviewed papers during 2019 and 2020. He is a hydrologist specialising in hydrological and groundwater modelling, with a focus on understanding groundwater recharge and aquifer baseflow in semi-arid environments.

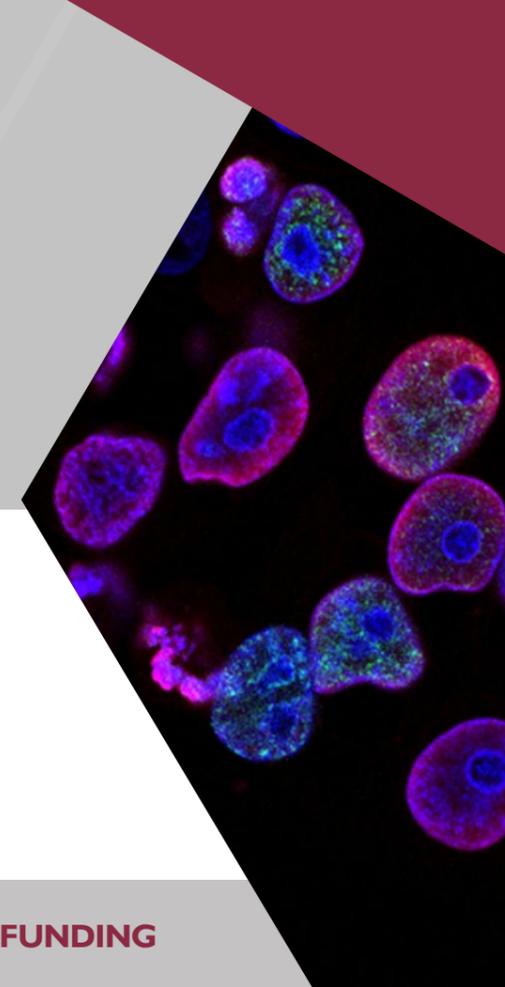
**Prof Gary Stevens** is part of BuCoMO, an IRP (International Research Project) associating French and South African researchers in geology, working on the origin and evolution of the continental crust. BuCoMO is funded by the CNRS and NRF from 2020 to 2024.

## STAFF MATTERS

**Prof Jodie Miller** has recently immigrated to Vienna, Austria, where she takes up a position as the Section Head of the Isotope Hydrology Section at the International Atomic Energy Agency (IAEA). This is an exciting career opportunity for Jodie, who will almost certainly make a success of it given her strong research background in isotope geochemistry. Jodie made invaluable contributions to our Department over her fifteen year tenure. These contributions included her excellent teaching and curriculum design initiatives, the countless students that she graduated, her involvement in the various societies, and her research outputs that spanned both isotope geochemistry and other fields of geology (e.g., metamorphic geology). Though we plan to stay in touch, Jodie will be sorely missed from our Department and we take the opportunity to wish her all the best for her future career endeavours.



Prof Jodie Miller. Photo: Stefan Els



**Dr Reynold Chow**, hydrologist and groundwater modeller from Canada, was appointed in the newly created position of hydrogeologist as of 1 July 2020. However, due to the Covid pandemic and delays in the visa process, his actual arrival has been postponed to the first half of 2021. He nevertheless contributed to our curriculum design with input in both our teaching and student supervision – made possible through online connectivity.

## SOCIAL IMPACT

The continuing collaboration between **Dr Matthew Mayne** in the Department of Earth Sciences at Stellenbosch University and Dr Mohit Melwani Daswani of the Jet Propulsion Laboratory, California Institute of Technology, on topics of planetary science has gained media attention with presentations at international conferences and a manuscript submitted to Geophysical Research Letters on the latest models investigating fluid content of Europa, a moon around Jupiter.

**Dr Susanne Fietz** gave a talk to the Somerset West Conversation Group DINK on “Climate change – the scientific facts” in February 2020.

## FUNDING

South Africa  
Anglo American  
CNRS/NRF funding to BUCOMO France/  
RSA  
DSI-NRF Centre of Excellence (CoE) for  
Integrated Mineral and Energy Resource  
Analysis (CIMERA)  
National Research Foundation (NRF),  
African Origins Platform (AOP)  
National Science Foundation (NSF),  
Frontier Research in Earth Sciences  
(FRES)  
NRF SARCHI funding  
Pan-African Resources  
Stellenbosch University, Early Career  
Advancement Grant 2020  
Stellenbosch University, Sub Committee  
B funding

## NRF - RATED RESEARCHERS

Internationally acclaimed researcher	Prof JD Clemens (retired)	granite petrogenesis
	Prof A Kisters	structural geology
	Prof G Stevens	experimental petrology
	Prof A Roychoudhury	environmental geochemistry, biogeochemistry and hydrogeology
Established researcher	Prof Jodie Miller	iotope geology, geohydrology
	Dr S Fietz	environmental geochemistry, biogeochemistry
Y-2	Dr B von der Heyden	earth sciences
	Dr R Tucker	earth sciences

STAFF LIST  
(AS AT THE END OF 2020)

## 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 researchers:

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 C Koegelenberg, Tect Consultancy  
 Dr N Phillips, Phillipsgold, Australia

## Support staff:

Dr 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 JL Menzel  
 Dr S Saumik  
 Dr A Watson

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DEPARTMENT OF  
MATHEMATICAL  
SCIENCES

## RESEARCH INTERESTS

## Applied Mathematics Division

Probability theory  
 Stochastic processes  
 Nonequilibrium statistical physics  
 Monte Carlo simulations  
 Computer vision, pattern recognition, machine learning  
 Fluid dynamics and modelling  
 Numerical analysis and scientific computing  
 Applied discrete mathematics

## Computer Science Division

Automata and grammars: theory and applications  
 Software engineering: program testing and verification  
 Machine learning, computational intelligence, and artificial intelligence  
 Data Science

## Mathematics Division

Algebra  
 Analytic number theory  
 Biomathematics  
 Category theory  
 Discrete mathematics and algorithms  
 Functional analysis  
 Model theory

## RESEARCH HIGHLIGHTS

**Dr James Gray** completed a research project, which was published in *Advances in Mathematics*, where he introduced Jacobi commutator semi-lattices and used them to show that Hall's criterion for nilpotency can be generalized from groups to a large class of semi-abelian categories.

**Prof Cang Hui's** research is continuing to advance the knowledge frontiers in Mathematical and Physical Biosciences. His work is widely cited, with over 7000 citations and the number of citations increased by 1315 citations in 2020 alone. His h-index is an impressive 43. He has been appointed as the trustee for the International Initiative for Theoretical Ecology (IITE, London) and was invited in 2020 as both Reviewer Editor and Contributing Author for the global assessment by the Intergovernmental

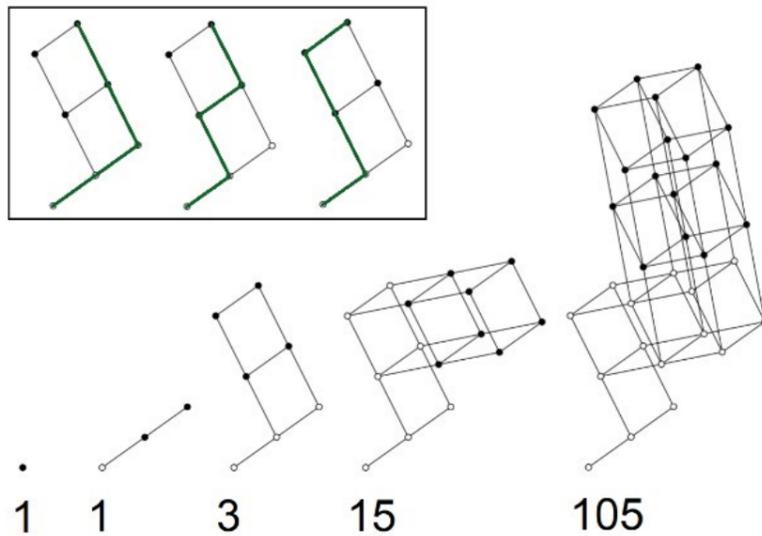
Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). In this way he is contributing to the university's core strategic theme of Research for Impact as well as one of the top 15 global challenges, namely sustainable development and climate change. A number of his publications received attention in the media. In particular, he was part of an international team of 24 scientists who have investigated the excessive high fire incidence in the Amazonian forest. They found that 85% of fires within the Amazon tropical moist forest occurred on areas deforested in the previous year and therefore argued strongly that "if left unchecked, the current trend of deforestation, fire expansion and forest degradation can cause catastrophic changes in Amazonia" (Environmental

Research Letters 15:121003). He was also part of an international team of 37 scientists assessed the drivers of potential alien species impacts under contrasting scenarios and socioecological contexts through the mid-21st century. Reported by Patrick Greenfield from *The Guardian* (15-Jul-2020), "The study found that tourism is a major driver of biological invasions in tropical regions, while the climate crisis is driving changes in polar and temperate areas". He is currently part of a research team, funded by UK's NERC, aim to conduct a comprehensive and predictive assessment of the pattern and consequences of global insect declines (GLITRS).

**Prof Hui** is also part of an international research team that has documented the impact of COVID-19 travel restrictions

on people's perceptions on air quality and transmission risks, as well as associated mobility patterns. Led by Dr Barbieri from the Norwegian University of Science and Technology, the team surveyed more than 9000 respondents during May 2020 from ten countries: Australia, Brazil, China, Ghana, India, Iran, Italy, Norway, South Africa and the United States. According to one publication from this research, "socio-economic inequality and morbidity are not only related to actual health risks, as well documented in the relevant literature, but also to the perceived risks". Together with his past postdoctoral fellow, he also analysed a model with an excellent fit to the data for 46 countries with 10,000+ cases (by 16 May 2020). The work predicted, "it is possible to defeat the COVID-19 pandemic by the end of 2020 through achieving a high damping rate (0.0615/day). However, the global damping rate is rather low (0.0504/day before 26 April) and has dropped even further since late April (0.0168/day). Easing currently implemented control measures in countries with weak or no damping in transmission could lead to an exponential rebound of COVID-19 spread" (Frontiers in Public Health 8:961). We are witnessing this predicted rebound in many places across the globe.

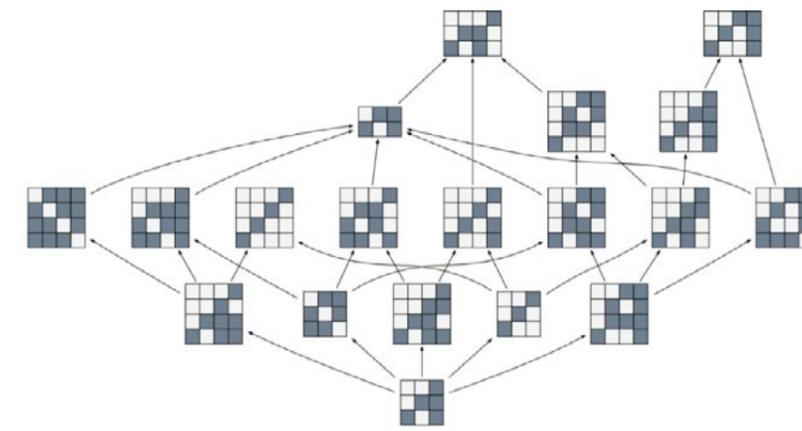
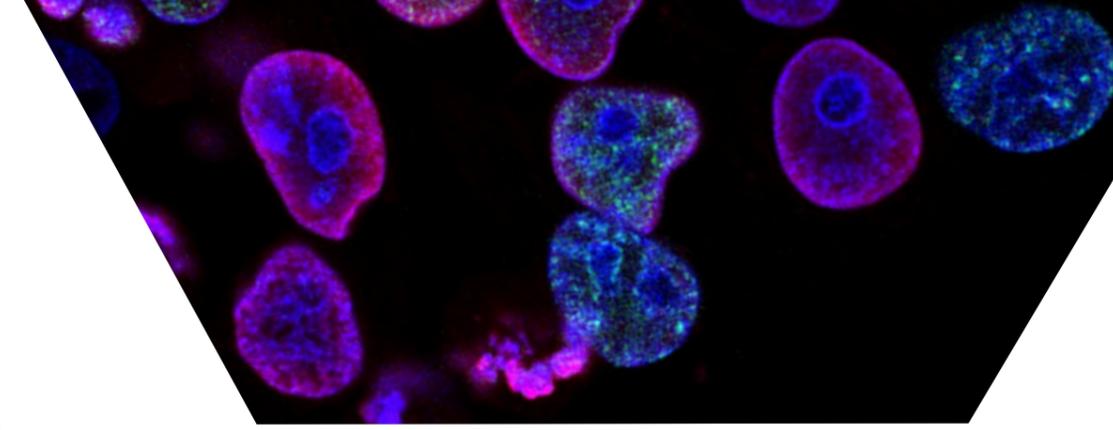
A collaboration of **Prof Zurab Janelidze**, Prof Helmut Prodinger and Dr FK van Niekerk in 2019 and 2020 led to introduction of new discrete geometric structures that bring together the fields of category theory, order theory and combinatorics. These structures arise as lax colimits (in the sense of category theory) of sequences of ordered sets. Their maximal chain numbers sometimes coincide with integer sequences familiar in combinatorics, but they can be extremely difficult to compute. One of the main results states that the maximal chain numbers for the partial lax colimits of the sequence of discrete hypercubes (equivalently, the ordered sets of subsets of a finite set) are precisely the odd double factorial numbers.



This image shows the first five terms of the sequence of partial lax colimits of discrete hypercubes and the corresponding maximal chain numbers, which are given by the familiar odd double factorial numbers. In simple language, these numbers count in how many ways can one traverse the displayed graph by starting with the bottom node of the graph, travelling always upwards along the edges of the graph, and reaching the top node. For example, there are three such traversals for the graph that appears as the third term in the sequence, as shown by the three green paths inside the top-left frame.

During the period 2019-2021, the categorical algebra research group has three papers that have appeared in *Advances in Mathematics*, which is one of the most prestigious international journals specifically dedicated to pure mathematics. Two of these papers mark the conclusion of research projects of Prof Zurab Janelidze and his collaborators, spanning over a period of more than five years. One of these research projects, completed in 2020, deals with a formalisation of the notion of an exactness property in category theory, and a general theorem for stability of certain exactness properties under the pro-completion, which unifies several such theorems established in the literature during 1986-2001. Another significant

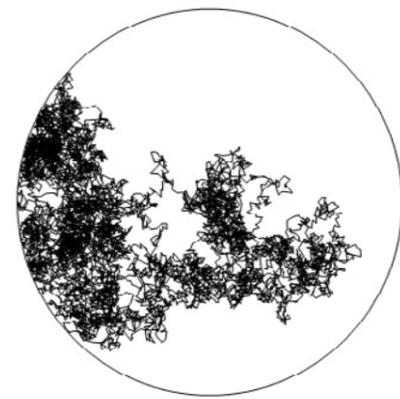
contribution to this area of category theory was made in joint work of Dr P.-A. Jacqmin, Dr MA Hoefnagel, and Prof Janelidze, where in 2020, based on the ideas proposed by Dr Hoefnagel, they were able to pave a way towards developing a computer program for computing various fragments of the partially ordered set of classes of categories defined by so-called matrix properties, which are a special type of exactness properties. This research opens an intriguing new link between the seemingly disjoint fields of computer and categorical algebra.



A computer-generated finite fragment of the infinite (partially) ordered set of classes of categories determined by matrix properties. Very little was previously known about this ordered set, and not much can be worked out by hand because of extensiveness of required computations. The results generated by the computer have so far not revealed any indications that the precise structure of this infinite ordered set can ever be fully determined.

In joint work of **Prof Janelidze** and his MSc student, Ineke van der Berg, a characterization of ordinal numbers in the style of Dedekind's classical approach to the natural number system, was developed in 2020. This research suggests interesting new topics of research in the overlap of category theory and set theory.

**Prof H Touchette**, together with MSc student Johan Du Buisson, completed the first study detailing how to adapt the theory of large deviations to diffusions with reflections. This study was published in *Physical Review E* in July 2020.

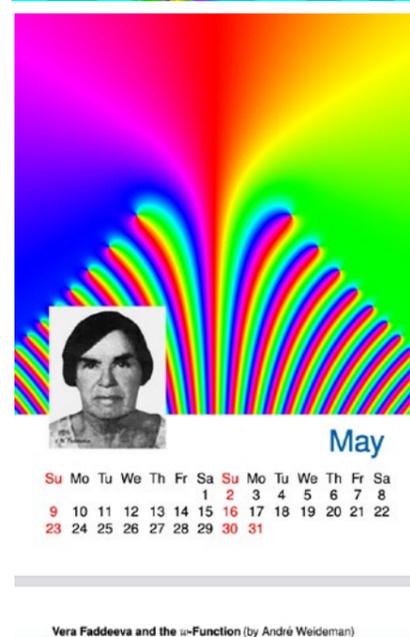
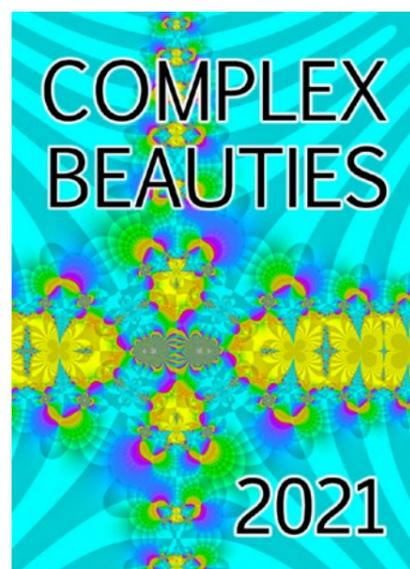


Example of stochastic process (in the case Brownian motion) evolving in a bounded domain (a disk) with reflections at the boundary. Image: Hugo Touchette

**Prof Leon van Wyk** published a 28-page joint paper, “Peirce decompositions, idempotents and ring”, with collaborators from the USA and Hungary in the prestigious *Journal of Algebra*.

**Prof JAC Weideman** was invited to write the content for the month of May 2021 in the well-known calendar series *Complex Beauties*, published by the Technical University of Freiberg in Germany. The full calendar can be downloaded from the page

<https://tu-freiberg.de/en/fakult1/anal-institute/institute-of-applied-analysis/organisation/complex-beauties>



Vera Faddeeva and the  $\zeta$ -Function (by André Weideman)

## RESEARCH ACTIVITIES

**Dr Bruce Bartlett** was on sabbatical for the first semester of 2020. He received the HB and MJ Thom Study Leave Award for a research trip to Germany. He was a Visiting Scientist at the Max Planck Institute (MPI) for Mathematics in Bonn for February and March, and was due to visit the Hamburg Mathematical Physics group in April, but the Hamburg trip was abandoned due to coronavirus pandemic. At the MPI he was an active member of the Topology group, gave a talk in the Topology seminar, and had very fruitful discussions with David Gay, Matthew Young, Stavros Garoufalidis as well as Don Zagier. Besides his sabbatical trip, another research highlight was a paper submitted with his PhD student Hosana Ranaivomanana on the fairly classical subject of the geometry of spherical tetrahedra. They noticed an interesting fact (the partial derivative of dihedral angle with respect to opposite edge length is equal to the reciprocal partial derivative) which does not seem to have been noticed before.

**Dr Dirk Basson** was on research leave from July to December 2020. The main aim of the research opportunity was to study the fields of definition of higher rank Drinfeld modular forms. He gained some valuable insights into the problem and the results are being written up with the aim of publication.

**Dr Gareth Boxall** gave two international seminar talks. The talk “Rational values of Weierstrass sigma-functions” at the online Logic Seminar hosted by the University of Campania, November 2020; and the talk “The definable  $(p,q)$  conjecture and distality” at the Logic Seminar hosted by the University of Manchester in February 2020. He visited Charlotte Kestner at Imperial College London in February 2020. Funding for this visit was provided by Imperial College London. His research collaboration with Gareth Jones, of the University of Manchester, continued. A central theme of this research has been to obtain upper bounds for the number of rational points of bounded height on the graphs of certain complex analytic functions. In 2020 they submitted a joint paper with Taboka Chalebogwa, concerning rational points on the graphs of certain Weierstrass sigma-functions.

This extended work in Taboka’s PhD thesis.

**Prof Willie Brink** presented a paper on Protea species identification at the IEEE Winter Conference on Applications of Computer Vision, in Snowmass, Colorado. He collaborated with the Centre for Invasion Biology at SU and Steve Kroon in the Computer Science Division on a project to re-identify Cape platanna individuals from photographs captured over time in the wild. He also worked with researchers from the South African Centre for Epidemiological Modelling and Analysis (SACEMA) and Shane Josias on a project to analyse tsetse fly wing images for understanding population dynamics, with Prof Benjamin Rosman from the University of the Witwatersrand on curiosity-driven reinforcement learning, and with InstaDeep on multi-agent reinforcement learning.

**Dr Hanno Coetzer** continued collaboration on automated dental implant recognition with KU Leuven; and on human-machine collaboration for biometric authentication with the University of Quebec. He made further progress with his three projects: Hand vein-based biometric authentication; Online and offline handwriting-based author identification; and automated detection of dicentric chromosomes in metaphase images.

**Prof Andries Engelbrecht** presented papers, tutorials, and keynotes at several conferences, including the Fourth International Conference on Intelligent Systems, Metaheuristics and Swarm Intelligence, IEEE Congress on Evolutionary Computational, Genetic and Evolutionary Computation Conference, International Joint Conference on Neural Networks, 12th International Conference on Swarm Intelligence, the 8th International Conference on Soft Computing and Machine Intelligence and the IEEE Swarm Intelligence Symposium. He was a guest speaker for a Science Café Stellenbosch event at Woordfees 2020, talking about Eugene Marais’ *Soul of the White Ant* as a forerunner of modern machine learning. He also delivered the keynote address, titled “A Hyper-heuristic Framework for Real-Valued Dynamic

Optimization”, at the International Conference on Intelligent Systems, Metaheuristics and Swarm Intelligence. He presented a tutorial, “Recent Advances in Particle Swarm Optimization Analysis and Understanding”, at the Genetic and Evolutionary Computation Conference and at the IEEE Congress on Evolutionary Computation. He delivered the keynote address, titled “Particle Swarm Optimization for Large Scale Optimization”, at the Congress on Intelligent Systems, and another keynote address titled “Multi-modal Optimization in Dynamic Environments using Particle Swarm Optimization” at the Workshop on Nature Inspired Optimization Techniques.

**Prof Sonia Fidler-Woudberg** continued with two projects in collaboration with the Department of Energy and Environmental Systems at IMT Atlantique in Nantes, France, on the “Permeability prediction 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”. The last project is to be published as a book chapter by Elsevier in 2021.

**Prof Berndt Fischer** presented the paper “Grammar-based testing for little languages: an experience report with student compilers” at the 13th International Conference on Software Language Engineering (SLE 2020).

**Dr James Gray** was on research leave from July to December 2020. During this period he completed three research projects, two of which have been submitted for publication and one of which has been published. These include a joint work with Prof Marino Gran from the Institut de Recherche en Mathématique et Physique of the Université Catholique de Louvain in Belgium. They have shown that under certain conditions action representability of a semi-abelian category implies action representability of the category of internal groupoids in it.

**Dr Trienko Grobler** collaborated with Dr Mattia Vicari from the University of Western Cape and with Dr Waldo Kleyhans from the University of Pretoria. He also attended the online 2020 IEEE

International Geoscience and Remote Sensing Symposium (IGARSS) in and the 21st IEEE International Conference on Mobile Data Management (MDM).

**Dr Karen-Therese Howell** hosted a virtual seminar series in place of the planned second African Women in Mathematics (AWiM) conference which unfortunately had to be postponed as a result of the pandemic. There were high-profile speakers, including Eugenia Cheng who launched her new book on gender stereotypes at the seminar, Federico Ardila, Carolina Aruajo, Nalini Joshi as well as emerging researchers from Africa.

**Prof Cang Hui’s** research team are working in the three research areas of biomathematics; adaptive network modelling; and biodiversity informatics. In 2020 Prof Hui was appointed as Reviewer Editor and Contributing Author for ongoing global assessment on invasive species led by the International Panel on Biodiversity and Ecosystem Services (IPBES). He also participated in an international research collaboration on the impacts of COVID-19 on mobility patterns and risk perceptions.

**Prof Zurab Janelidze** was invited to give two online talks: at the newly established Panglobal Algebra and Logic Seminar organised by the University of Colorado (USA), and the Algebra, Logic and Topology Seminar of the Centre for Mathematics of the University of Coimbra (Portugal). The categorical algebra research group hosted the visit of Dr P.-A. Jacqmin from the University of Louvain-la-Neuve (Belgium) in January 2020. This visit led to starting a number of new joint research projects, as well as completion of an existing joint project with Prof Janelidze on exactness properties, which was submitted and accepted for publication in *Advances in Mathematics* in 2020.

**Prof Steven Kroon** collaborated or co-supervised together with Dr Simukai Utete from AIMS-SA; Dr McElroy Hoffmann from Praelexis; Prof Luc de Raedt from KU-Leuven; Dr Arnu Pretorius from Instadeep; Dr Herman Kamper from SU’s Department of Electrical and Electronic Engineering; Dr Steve James and Prof Benjamin Rosman from the University of the Witwatersrand;

and Prof Sebastian Stiller from Technical University (TU) Braunschweig. He presented a paper at the 23rd International Conference on Information Fusion (FUSION 2020) and served as the external supervisor of Felix Reimers, an MSc student at TU Braunschweig.

**Dr Sophie Marques** is collaborating with Dr Ben Blum-Smith from New York University (USA) on good and bad primes; Prof Valentijn Karemaker from the Mathematics Institute at Utrecht University (Netherlands) and Prof Jeroen Sijlsing from the Institute of Algebra and Number Theory at Ulm University (Germany) on cubic function fields with prescribed ramification; **Dr K-T Howell** from SU on an intuitive understanding of the structure of near-vector spaces (submitted); Dr K-T Howell and Dr L Boonzaaier from SU on real regular inner product near-spaces. She was involved with supervising the masters projects of two AIMS-SA students in 2020 and co-supervising, with Mariam Salie in SU’s Department of Psychology the masters research of Lesley Scott on “Perceptions and Lived Experience: Exploring Factors That Affect Student Retention in Mathematics”.

**Dr Mkhusele Ngxande** attended and presented two papers at the SAUPEC/RobMech/PRASA 2020 in Cape Town, South Africa. The conference incorporates the Southern African Universities Power Engineering Conference (SAUPEC), the Robotics and Mechatronics Conference of South Africa (RobMech) and the Annual Symposium of the Pattern Recognition Association of South Africa (PRASA).

**Prof Ingrid Rewitzky** was invited to write a book chapter for *Enhancing Science Education: Exploring knowledge practices with Legitimation Code Theory and for Reconceptualising academic development: A South African perspective* (with Dr H Adendorff and Dr I. Rootman-Le Grange), as well as a book review for *Studia Logica* on the book *Ewa Orłowska on Relational Methods in Logic and Computer Science* published in 2018 as part of the *Springer International Publishing Series: Outstanding Contributions to Logic*.

She participated in the panel discussion “How do you anticipate the Grade 12 class of 2020 being affected by the COVID-19 pandemic, and what does this mean for the 2021 university intake?” at the third annual Diagnostic Mathematics Information for Student Retention and Success (DMISRS) Project symposium, November 2020 and in the CARE note opening session of the SU Scholarship of Teaching and Learning (SoTL) Conference, November 2020.

**Dr Riana Roux** hosted Drs Magda Detlaff and Magda Lemanská from Gdańsk University of Technology as part of an Erasmus + exchange program. She was an invited speaker at Combinatorics and Related Topics 2020, presented by Universidad Nacional Autónoma de México.

**Prof Hugo Touchette** presented two international seminar talks via Zoom. The talk “Numerical computation and estimation of large deviations” was presented to the Statistical Physics and Complexity Group in the Department of Physics at University of Edinburgh, Scotland, 1 July 2020; the second talk was on “Classical and quantum processes with random resetting” for the Department of Physics at the University of KwaZulu-Natal (UKZN), 18 June 2020.

**Prof Brink van der Merwe** collaborated with Prof Wolf-Tilo Balke, holder of the Chair for Information Systems at TU Braunschweig, and with Dr Martin Berglund from Umeå (Sweden) and presented their research at the 2020 annual virtual conference of the South African Institute for Computer Scientists and Information Technologists (SAICSIT).

**Prof Lynette van Zijl** collaborated with Prof Jackie Daykin from Aberystwyte University (United Kingdom) under the Global Challenges programme and with Dr Matthew Schurch from the Landmark Foundation on image processing in nature conservation.

During the lockdown period, **Prof JAC Weideman** worked with Prof Nick Trefethen and Prof Yuji Nakatsukasa from Oxford University to write a paper titled “Exponential node clustering at singularities for rational approximation, quadrature, and PDEs”, published in the journal *Numerische Mathematik* in 2021.

This work also featured prominently in Trefethen’s John von Neumann Lecture, one of the Society of Industrial and Applied Mathematics’ (SIAM) major accolades.

Several of our researchers received international visitors prior to the COVID-19 lockdown restrictions.

**Prof Andries Engelbrecht** hosted Dr Michal Pluhacek from Tomas Bata University in Zlin (Czechia) as part of an Erasmus Plus grant.

**Prof Steven Kroon** hosted a research intern, Manupriya Gupta, from the Indian Institute of Technology (IIT) in Delhi (India) during May-June 2020.

**Dr Mkhusele Ngxande** hosted Matisse Ghesquière from Ghent University (Belgium) as part of an international student exchange programme, from February-June 2020.

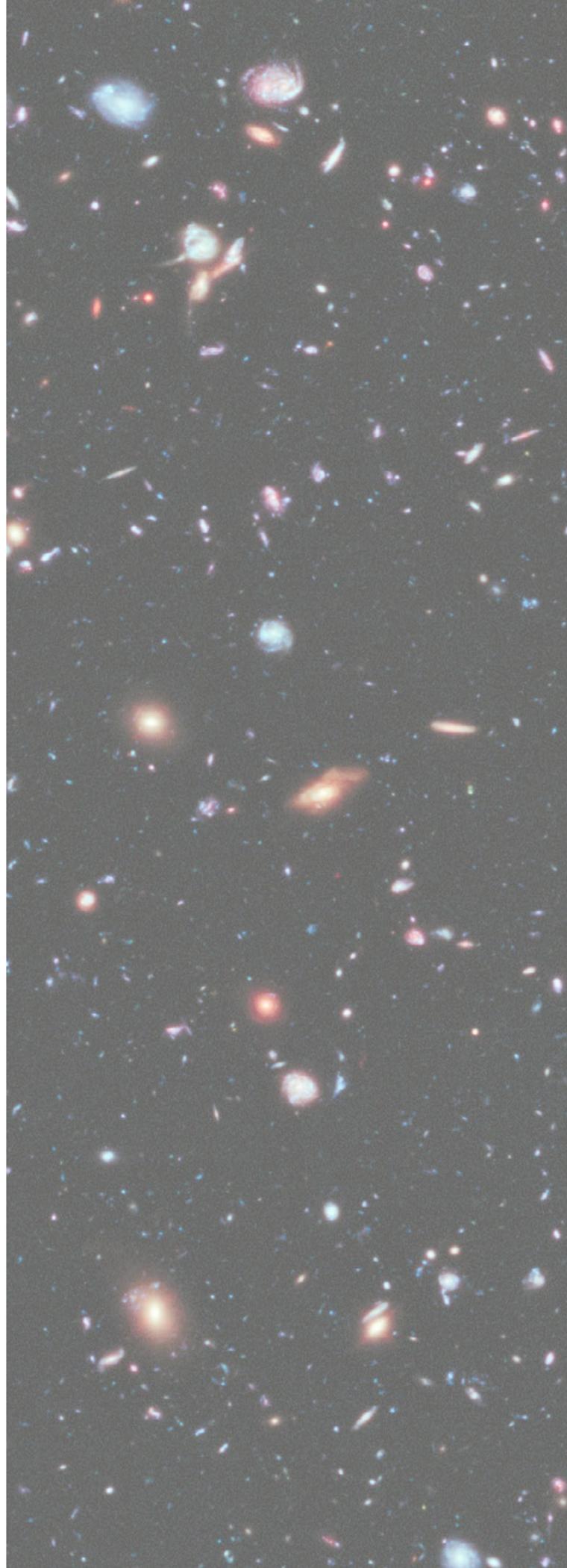
**Prof Leon van Wyk** hosted Prof Michal Ziemkowski from Warsaw University of Technology (Poland), collaborating on Lie properties in associative algebras and on Leavitt path algebras.

## SERVICE TO THE SCIENTIFIC COMMUNITY

In May 2020, Dr Jared Ongaro from the School of Mathematics at the University of Nairobi (Kenya) approached

**Dr Bruce Bartlett** and other mathematicians around the world to be co-hosts in starting up an online **African Mathematics Seminar** via Zoom.

The first seminar was held on 27 May 2020, and there have been 35 seminars since then! It is a weekly seminar for the whole of Africa, and each week a different region is given the opportunity to host the seminar, thereby alternating through the entire continent, country by country. The goal is to build mathematical networks across Africa and showcase African mathematical talent. Speakers often hail from Africa, or have a strong relationship with African mathematics. Seminars have been presented by some high-profile speakers, including two Fields medallists, but also up-and-coming PhD students. Each seminar has 50 participants on average. From 19-20 November 2020 Dr



B Bartlett, together with the organisers of the African Mathematics Seminar, hosted an online conference on Technology in Mathematical Sciences Education.

During 2020 **Prof Andries Engelbrecht** was chair of the IEEE Computation Intelligence Society’s South African Chapter; vice-chair of the Evolutionary Computation Technical Committee of the IEEE Computational Intelligence Society; senior member of the Institute of Electrical and Electronics Engineers (IEEE); advisory board member of Machine Intelligence Research Labs; technical advisor for the fintech company NMRQL Research in Stellenbosch; technical advisor for Merlynn Intelligence Technologies in Centurion.

**Prof Berndt Fischer** was chair of the steering committee of the Automated Software Engineering conference series. He is a member of the ASE/ESEC-FSE/ICSE conference coordination group; and of the the International Federation for Information Processing Technical Committee-2 (IFIP TC-2) Working Group 2.11. He is a member of the Program Committee and Board of the International Conference on Automated Software Engineering (ASE), the International Conference on Software Engineering (ICSE), the ICSE Doctoral Symposium, the ICSE Workshop Selection Committee, the International Colloquium on Theoretical Aspects of Computing (ICTAC), and the international conference on Software Analysis, Evolution and Reengineering (SANER).

**Prof Nick Hale** is chair of the local organising committee for the fifth BRICS Mathematics and Statistics Conference to be hosted in Stellenbosch in 2022.

**Dr Karin-Therese Howell** is a member of the AIMS-SA Executive Council, and secretary of the South African Mathematical Society’s council.

**Prof Cang Hui** is a member of the advisory board of three consortiums: AlienScenarios, hosted by the University of Vienna (Austria); the Cadotte Urban Biodiversity and Ecosystem Services Lab (GUBIC) at the University of Toronto (Canada); and ALIENIMPACTS hosted by King’s College, London (United Kingdom).

**Prof Ingrid Rewitzky** served as an

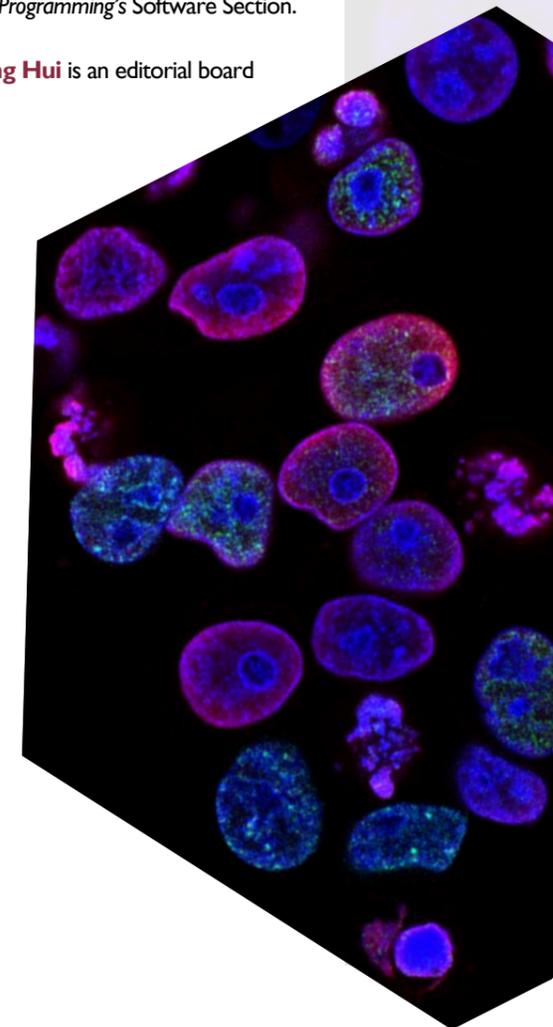
external review panel member for the review of the Science Extended Curriculum Programme at the University of Cape Town, from October-December 2020. She is also a member of the International Mathematical Union Committee on Electronic Information and Communication (CEIC).

## EDITORIAL ACTIVITIES

**Prof Andries Engelbrecht** is associate editor of a number of journals. They are: *IEEE Transactions on Evolutionary Computation*, *IEEE Transactions on Neural Networks and Learning Systems*, *Swarm Intelligence Journal*, *Complex & Intelligence Systems*, *Engineering Applications of Artificial Intelligence and Artificial Intelligence*. He is also series editor for *IntechOpen Series*, and serves on the editorial board of *Evolutionary Computation Journal* and the Springer book series *Studies in Autonomic, Data-Driven and Industrial Computing*.

**Prof Berndt Fischer** is an editorial board member of the journal *Science of Computer Programming’s* Software Section.

**Prof Cang Hui** is an editorial board



member of the journals *Global Ecology and Biogeography* and *Bulletin of Mathematical Biology*.

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

**Prof Brink van der Merwe** is associate editor for the *Journal of Universal Computer Science*.

**Prof Leon van Wyk** is associate editor of *Afrika Matematika*.

**Prof Lynette van Zijl** is associate editor of the *Journal of Universal Computer Science*.

**Prof Willem Visser** is associate editor of *IEEE Transactions on Software Engineering (TSE)*.

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

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

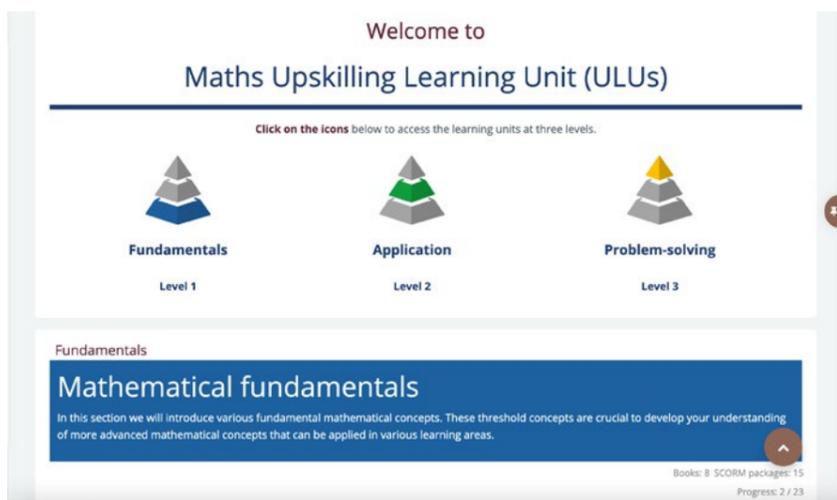
## ACADEMIC AFFAIRS

As colleagues and students adapted to remote teaching, learning, and assessment during 2020, there was much collaboration on building knowledge and expertise in this new mode of offering our academic programmes. Some innovative teaching and learning and assessment projects emerged, including: rethinking of in-person teaching and learning activities as we prepared for augmented teaching, learning, and assessment in 2021; new ideas and solutions around effective online assessment in Mathematics; and meaningful feedback via a “feedback video”, where the lecturer records a video of an on-screen marking of a student’s assignment, while making detailed vocal commentary.

Three new programmes were approved by the Department of Higher Education and Training (DHET):

- BSc in Computer Science to be offered from 2022 (SAQA approval pending);
- BDatSci to be offered from 2021 – in collaboration with Department of Statistics and Actuarial Science and various other environments; and
- MSc (Machine Learning and Artificial Intelligence) to be offered from 2022.

Mathematical Upskilling Learning Units (ULUs) have been designed and implemented by Dr Jacques Masuret (Mathematics), Mrs Bessie Burger (Mathematics), and Mr Rondey Randall (Faculty of Economic and Management Sciences).



Each ULU covers a special mathematical topic or skill, including, fractions, exponents, radicals, ratio and proportion, timelines, algebraic expressions, trigonometry and number sense. The ULUs offer an online, interactive, and gamified learning experience that will be adaptable and engaging in a pedagogically effective way. In addition, the ULUs offer a scaffolded learning process, informed by Bloom’s taxonomy, to enable self-paced learning for students with different levels of mathematics proficiency.

From 2021, the Math ULUs will be customized into a two-week learning activity which will be compulsory for all the Extended Degree Programme Students and which will be available as an additional upskilling resources for self-enrolment by all students registered for a first-year mathematics module. In the future, a short course will be customised from the Mathematics ULUs, with a view to increasing the pool of applicants for programmes across the university with Grade 12 mathematics as an entrance requirement and also requiring students to be proficient in their mathematical understanding and reasoning skills.

## AWARDS TO STAFF AND STUDENTS

**Prof André (JAC) Weideman** is internationally recognised as one of the most creative figures in numerical analysis, specifically for his research on the interface between complex analysis and numerical algorithms in application fields such as differential equations, integral transforms and special functions. Over a career spanning more than thirty years, he has made a valuable contribution to the improvement of software by applying his theoretical knowledge to develop practical algorithms.

In recognition for his research excellence, Prof Weideman was awarded the Havenga Prize for Physical Sciences. The Havenga Prize is an annual award for original research in the natural sciences and can be awarded only once to an individual. In reaction to the award, Prof Weideman said the award is special even more so as applied mathematicians’ research contributions often remain invisible to the popular media: “Applied mathematics is a subject in the service

of the rest of the sciences. For someone who spent his academic career on improving computer algorithms for effective use by other scientists, this award is extremely special”.

Prof Weideman was also promoted to Distinguished Professor of Applied Mathematics at Stellenbosch University and received the SU Chancellor’s Award for Research in December 2020.



Prof André Weideman

**Prof A Fransman, Dr J Gray, Dr K-T Howell, Dr J Masuret, Dr S Marques, Prof H Touchette** each received a First-year Achievement Award for being nominated as lecturer who made the greatest contribution to a top achieving first-year student’s academic experience.

**Prof Cang Hui** received an SU Research Output Award and the Most Cited Paper Award from the Ecological

Society of Japan’s journal, *Population Ecology*.

**Dr Sophie Marques** was a finalist in the science engagement category of the Falling Walls Conference held during the Berlin Science Week in November 2020. This was for *Wisaarkhu*, a multidisciplinary project aimed at humanising mathematics.

**Dr Marcela Espinaze**, a postdoctoral fellow in Prof Cang Hui’s research group, was selected by Cambridge University Press’ journal *Parasitology* for the 2020 Early Career Researcher Award for the best paper published in the journal during 2020. The paper, entitled “Parasite diversity associated with African penguins (*Spheniscus demersus*) and the effect of host and environmental factors”.

**Prof Willem Visser** received the 2020 ACM SIGSOFT Impact Paper Award for his paper titled “Model Checking Programs” at the IEEE international conference on Automated Software Engineering (ASE) 2000.

Top achievers in Applied Mathematics for the 2019 academic year were rewarded for their hard work with certificates and book prizes sponsored by Cambridge University Press. They were: Jason Scott Brown and Jean Durand (best first year students), Eugene Fouché (best second year student), Tarryn Surajpal (best third year student) and Klara Kleinhans (best Honours student).

The following students received book prizes as part of the Rubbi Awards for Mathematics for the 2019 academic year: Muhammad Dollie and Wicus van der Linden (best first year students), Jacobus Olivier and Jean van der Walt (best first year engineering mathematics students), Eugene Fouché and Joshua

Putterill (best second year students), Dario Trincherio and Conrad Strydom (best third year students), Nicola Brill and Andrew Harrison-Migochi (best Honours students).

Unfortunately, the annual prize-giving event for the top achieving Computer Science students for the 2019 academic year was not held in 2020 due to the COVID-19 regulations.

On postgraduate level, Mr Mpendulo Cele was awarded the prestigious S2A3 medal for the best MSc student at SU in the natural, engineering and medical sciences. The S2A3 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. Mpendulo will now continue with his doctoral research in Number Theory under the guidance of Dr Sophie Marques.



Mr Mpendulo Cele

## SOCIAL IMPACT

### FIRST EDITION OF WISAARKHU ADDRESSES COLLABORATION VERSUS COMPETITION

The Psychology of Abstract Mathematics magazine *Wisaarkhu*, founded and managed by Dr Sophie Marques, was launched in February 2020 with the publication of a themed edition of *Wisaarkhu* around “Collaboration or Competition”. Four main topics addressing the main theme of the volume are covered, namely perspectives within and beyond mathematics, voices of students, impact on the self, and influence on learning and teaching of mathematics. *Wisaarkhu* aims to provide a diversity, not necessarily a jointly exhaustive collection, of perspectives on a chosen theme related to the learning, teaching and research of Mathematics. It is a magazine for inspiring, for creating awareness, for sharing experiences, for communicating, for connecting, and for reflecting. It is not a research journal. It does not purport to endorse any particular opinion or approach to the learning and teaching of mathematics. Its readership is intended for all from across the globe with an interest in mathematics. The second edition of *Wisaarkhu* will address the stigma around Mathematics.

### ONLINE POW SEMINAR FOR HIGH SCHOOL LEARNERS

On 7 October 2020, the Faculty of Science hosted an online POW (Patterns Open Worlds) event for high school learners. Dr Gareth Boxall helped organise it and took part on the day, introducing speakers and asking them questions after their presentations. The 15-minute talks were presented by Dr Bruce Bartlett – “Is there a knot in my cable?”; Dr Hardus Diedericks – “Applied Mathematics: a real-world environmental problem”; Prof Hugh Patterson – “Bioinformatics: using computers to understand life”; and Dr Sophie Marques – “From symmetries to groups”. The event was concluded with a Q&A session and prize-giving for quiz winner(s).

## OUTREACH INITIATIVES

**Prof Willie Brink** participated in the Deep Learning Indaba mentorship programme, as a mentor to students from across Africa. He also adapted the popular Maties Machine Learning seminar series to an online format.

**Prof Berndt 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 for creating, transferring, commercialising and exchanging knowledge within and between sub-Saharan universities and industries. He also secured and coordinated a laptop donation by Payat to first and second year BCI Computer Science students.

**Prof Cang Hui** and his research group offered a regular ‘Theoretical Ecology Journal Club’ online via Teams/Zoom. As the trustee of the International Initiative for Theoretical Ecology (IITE, London), he also hosts a bi-weekly online seminar series on modelling and theoretical ecology presented and attended by scientists across the globe.

**Prof Steven Kroon** developed an open curriculum on the material required for the paper “Variational Inference with Normalizing Flows” as part of the DepthFirstLearning initiative ([depthfirstlearning.com](http://depthfirstlearning.com))

**Dr Sophie Marques** organised, together with the *Wisaarkhu* team, three special virtual discussions during 2020, namely “Teaching and learning maths with psychological advice during the pandemic” on 11 July 2020, “The Mathematics of the pandemic” on 25 July 2020, and “Experience of the pandemic across disciplines” on 8 August 2020. These discussions inspired a special edition of *Wisaarkhu* titled “Mathematics during the Pandemic”.

**Prof Hugo Touchette** gave an introductory lecture on machine learning and artificial intelligence in Africa and South Africa to the BAHonours

journalism students at Stellenbosch University on 15 October 2020.

**Prof Lynette van Zijl** continued her ongoing collaboration with the Pioneer School for the Blind in Worcester on technological innovation in teaching the blind. Several projects implemented by Honours students are now used at the school, including a translation system from Afrikaans into Duxbury-printable Braille.

## STAFF MATTERS

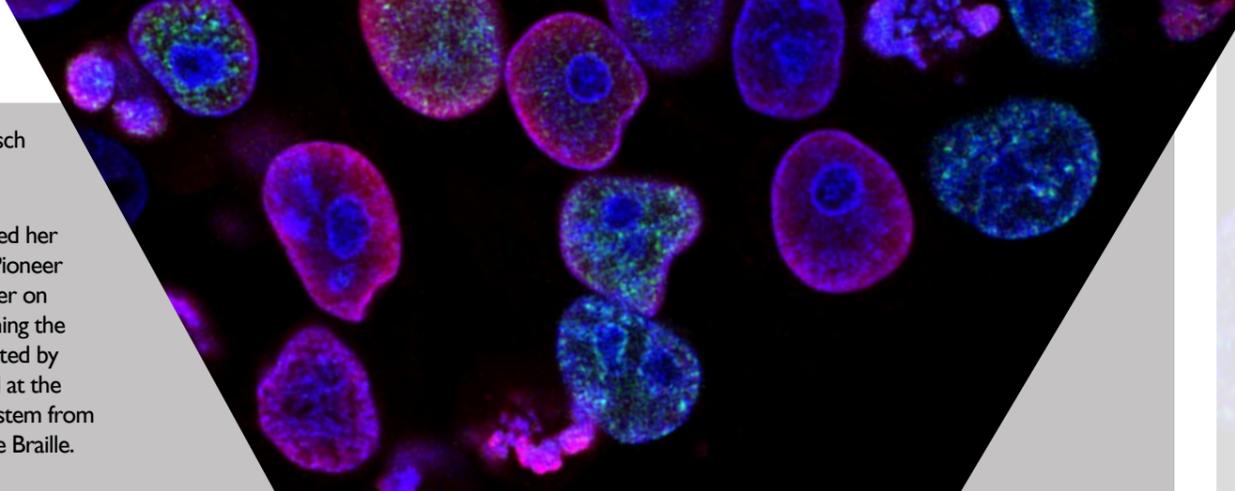
**Prof Helmut Proding** decided to retire with effect from 1 September 2020. Based on the high quality of his research outputs and his research publication output units per year, Prof Proding has contributed significantly to the research excellence of the Department of Mathematical Sciences, the Faculty of Science, and Stellenbosch University. He has been appointed Emeritus Professor of Mathematics at SU from 1 September 2020.

**Prof Willem Visser** changed to a part-time position to take up position as Senior Principal Applied Scientist at Amazon Web Services (USA).

**Prof Jaco Geldenhuys** resigned to take up position as Principal Applied Scientist at Amazon Web Services (USA) from 1 September 2020.

**Mrs Hayley du Plessis** resigned from her position as Administrative Officer in Computer Science with effect from 1 January 2021.

A significant effort has been made to fill vacancies in the department. **Dr Liam Baker** took up the position of lecturer in Mathematics with effect from 1 July 2020 and five appointments were secured with effect from early 2021: **Dr Marcel Dunaiski** as Lecturer in Computer Science, **Mr Shane Josias** as Junior Lecturer in Applied Mathematics, **Dr Pietro Landi** as Lecturer in Applied Mathematics, **Dr Francois van Niekerk** as Lecturer in Mathematics, and **Prof Bill Tucker** as Associate Professor in Computer Science.



**Prof Willie Brink** was reappointed Division Head of Applied Mathematics, from 1 January 2021 to 31 December 2022. **Prof Leon van Wyk** was reappointed Division Head of Mathematics, from 1 July 2020 to 30 June 2022. **Prof Ingrid Rewitzky** was reappointed for a fourth three-year term as Vice-Dean: Teaching and Learning of the Faculty of Science from 1 October 2020 to 30 September 2023.

## FUNDING

**Dr Bruce Bartlett’s** application for the DAAD In-Region Scholarships for MSc and PhD study in the Mathematics Division was successful. The division was awarded five MSc and six PhD scholarships per year for the intakes 2021 to 2023. For 2021, four MSc and four PhD scholarships were allocated.

**Prof Willie Brink** secured eight full scholarships from DeepMind Technologies for MSc and PhD students focusing on machine learning. SU is the first university in Africa to partner with DeepMind in their scholarship programme. He also obtained funding from the Strategic Fund of SU for start-up capital for the new structured MSc in Machine Learning and Artificial Intelligence, and funding from the Strategic Fund of SU and the School of Data Science and Computational Thinking to appoint Shane Josias as a Junior Lecturer in Applied Mathematics.

**Prof Berndt Fischer** secured funding from the NRF’s Competitive Programme

for Rated Researchers (CPRR); from the Royal Academy of Engineering in the United Kingdom; and from the Swedish Foundation for International Cooperation in Research and Higher Education (STINT).

Besides **Prof Cang Hui’s** SARCHI grant, he also received a number of grants as partner investigator, including: the University Staff Doctoral Programme: Building Capacity in Applied Mathematics (USDP-BCAM) grant funded by the Newton Foundation, the British Council and the Department of Higher Education and Training; the UK Natural Environmental Research Council (NERC); the Australian Research Council (ARC) grant coordinated by Monash University and La Trobe University; the International Development Research Centre (IDRC, Canada) grant coordinated with the African Climate and Development Initiative (ACDI) based at the University of Cape Town (UCT); and funding for a working group from the National Institute for Mathematical and Biological Synthesis (NIMBioS) at the University of Tennessee. The latter has been postponed due to pandemic.

**Prof Lynette van Zijl** obtained funding from the NRF’s Competitive Programme for Rated Researchers; and from Global Challenges (United Kingdom).

**Prof Brink van der Merwe** obtained funding via the Erasmus+ EU project in collaboration with universities in Sweden, Finland and Russia.

**NRF - RATED RESEARCHERS**

Leading international researchers	Prof A Engelbrecht	Artificial Intelligence
	Prof H Prodinge	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	Matrix algebras, Lie properties in associative algebras, Leavitt path algebras
	Prof H Touchette	Theory of large deviations
	Prof JAC Weideman	Numerical analysis and scientific computing
Established researchers	Dr G Boxall	Model theory and some aspects of number theory
	Prof J Geldenhuys	Software engineering and specifically model checking and process algebra
	Dr K-T Howell	Near-vector spaces
	Prof RS Kroon	Machine learning
	Prof S Mouton	Banach algebras and spectral theory
	Prof AB van der Merwe	Automata theory
	Prof L van Zijl	Automata theory
Promising young researchers	Prof S Fidler-Woudberg	Fluid modelling
	Dr J Gray	Category Theory
	Dr T Grobler	Remote sensing data
	Dr N Hale	Numerical analysis and scientific computing
	Dr N Ralaivaosaona	Analytic number theory, Probabilistic combinatorics
	Dr R Roux	Graph theory

**STAFF LIST (AS AT THE END OF 2020)**

**Academic:**

Dr B Bah (jointly with AIMS-SA)  
 Dr L Baker (from 1 July 2020)  
 Dr B Bartlett  
 Dr DJ Basson  
 Dr R Benjamin  
 Mr W Bester  
 Dr G Boxall  
 Prof W Brink (Division Head: Applied Mathematics)  
 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)  
 Prof S Fidler-Woudberg  
 Prof B Fischer (Division Head: Computer Science)  
 Prof J Geldenhuys (until 31 August 2020)  
 Dr JRA Gray  
 Dr N Hale  
 Dr R Heymann  
 Dr M Hoefnagel  
 Dr K-T Howell  
 Prof C Hui (SARCHi)  
 Dr CP Inggs  
 Dr Z Janelidze  
 Prof RS Kroon  
 Dr MF Maritz  
 Dr S Marques  
 Dr J Masuret  
 Prof S Mouton  
 Mr S Mungwe  
 Dr M Ngxande  
 Prof H Prodinge (until 31 August 2020)  
 Dr D Ralaivaosaona  
 Prof IM Rewitzky (Executive Head)  
 Dr R Roux  
 Prof F Smit  
 Prof H Touchette  
 Prof AB van der Merwe  
 Prof L van Wyk (Division Head: Mathematics)  
 Prof L van Zijl  
 Prof WC Visser  
 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  
 Prof H Prodinge (from 1 September 2020)

**Support staff:**

Mrs L Adams  
 Mrs H du Plessis  
 Mrs V du Plessis (until 30 April 2020)  
 Mrs S Fortuin  
 Mrs W Isaacs  
 Mr B Jacobs (until 31 March 2020)  
 Mrs L Muller  
 Mr A Roman  
 Ms M Sebastians (from 1 May 2020)  
 Mr D Stephanus  
 Mrs C Williams (from 1 August 2020)

**Postdoctoral Fellows:**

Dr D Nickelsen, joint with AIMS and NITheP  
 Dr P Landi  
 Dr J Rodger  
 Dr S MacFadyen  
 Dr S Gumede

**COLLABORATION**

**Australia**

Griffith University  
 University of New South Wales

**Belgium**

KU-Leuven  
 Université Catholique de Louvain  
 University of Louvain-la-Neuve  
 Ghent University

**Canada**

Brock University  
 University of Quebec

**Czech Republic**

Tomas Bata University of Zlin

**Cyprus**

Research Centre on Interactive Media, Smart Systems and Emerging Technologies  
 University of Cyprus

**France**

IMT Atlantique in Nantes

**Germany**

Braunschweig University of Technology

**Hungary**

Renyi Institute of Mathematics

**India**

Indian Institute of Technology Roorkee

**Ireland**

Trinity College, Dublin

**Nigeria**

Federal University of Dutse, Dutse

**Poland**

Gdańsk University of Technology  
 University of Miskolc  
 Warsaw University of Technology

**South Africa**

Council for Scientific and Industrial Research (CSIR)  
 University of Cape Town  
 University of Johannesburg  
 University of Pretoria  
 University of South Africa  
 University of the Western Cape  
 University of the Witwatersrand

**Spain**

Institute of Agriculture and Food Research and Technology, Barcelona  
 University, Fuenlabrada

**Sweden**

Umeå University

**United Kingdom**

Aberystwyth University  
 Imperial College London  
 Lancaster University  
 University of Manchester  
 University of Oxford

**United States of America**

University of Louisiana at Lafayette  
 Machine Intelligence Research Labs,  
 Auburn, Washington

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[secretary@cs.sun.ac.za](mailto:secretary@cs.sun.ac.za)

Web: <http://www.cs.sun.ac.za>  
 Facebook: <https://www.facebook.com/groups/csmaties/>

**Mathematics Contact details**

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 Web: <http://www.sun.ac.za/english/faculty/science/Mathematics>

# DEPARTMENT OF MICROBIOLOGY

## RESEARCH INTERESTS

- Bioprocessing**
- Enzyme engineering and bioinformatics**
- Lactic acid bacteria**
- Microbial ecology and mycology**
- Water treatment**
- Fungal biotechnology for bioenergy and the bioeconomy**
- Functional microbial bioinformatics**
- Biotechnologies for water treatment**
- Interactions of opportunistic pathogens**
- Biofilm ecology**
- Wastewater-based epidemiology**
- Environmental Analytical Chemistry**
- Eco-toxicology**

## RESEARCH HIGHLIGHTS

### FRAUNHOFER INNOVATION PLATFORM FOR WATER-ENERGY-FOOD NEXUS AT STELLENBOSCH UNIVERSITY

The Fraunhofer-Gesellschaft and Stellenbosch University consolidated their long-standing collaboration with the establishment of this strategic platform in 2020. The goal of the partnership is to develop sustainable solutions to promote water, energy and food security. An online kick-off meeting was held on 28 May 2020, with participants from Fraunhofer Alliances SysWasser and Energy, Headquarters, Stellenbosch University's Water Institute (SUWI) and Center for Renewable and Sustainable Energy Studies (CRSES), followed by a strategic online workshop on 9 July 2020. Two of the research projects supported by the platform includes the ICON water supply technologies for desalination and microbial control in food production for Africa (WASTEC) project, coordinated by Dr Marelize Botes; and MSc student, Ms Carli Louw as well as the DemoMed-Ver project to develop decentralised mobile care with autonomous test platforms for use in developing countries led by Dr. Martin Hamann (FIP).

### STELLENBOSCH RIVER FILTER

The River Filter, located on the banks of the Eerste River in Stellenbosch, aims to remediate polluted river water for subsequent use in produce irrigation and to further our understanding of plant and microbial interaction in the uptake and removal of micropollutants. The project is a collaboration between Wildlands,

Distell, and Stellenbosch Municipality, with funding from First Rand, Stellenbosch University Central Analytic Facility, and the National Research Foundation (NRF) and involve one PhD student and two MSc students from the research group of Prof Gideon Wolfaardt.

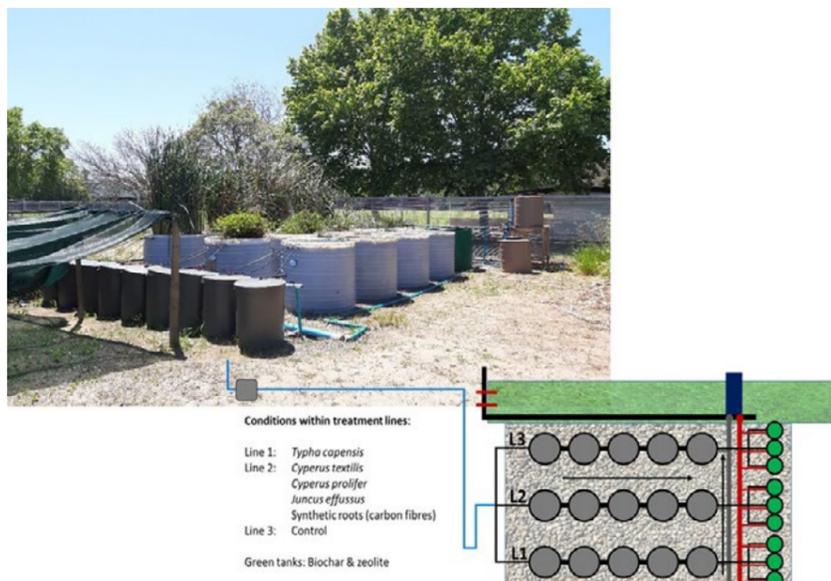
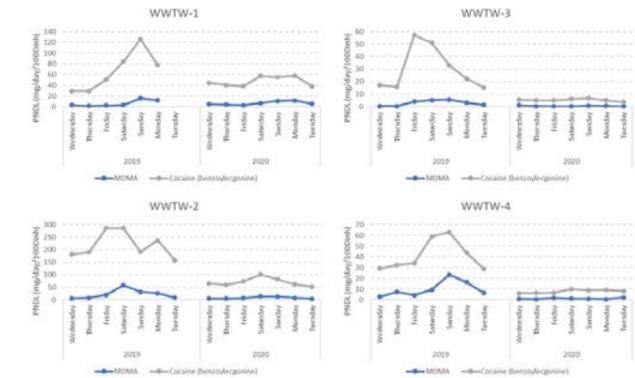


Image and configuration of the river filter constructed on the banks of the Eerste River, Distell site, Stellenbosch. Photo: Alno Carstens

### DEVELOPING RESILIENT NATIONS: TOWARDS AN EARLY WARNING SYSTEM FOR PUBLIC- AND ENVIRONMENTAL HEALTH (RENEW)

This multi-disciplinary project involved the collaboration of researchers from various disciplines in the natural sciences, social sciences, and engineering at the University of Bath (UK) and the research groups of Prof Gideon Wolfaardt, Dr Edward Archer and Keira Tucker (Microbiology) and Dr Tobias Louw (Process Engineering) at Stellenbosch University. The aim was to identify microbial- and chemical biomarkers of exposure and effect in urban surface waters as well as wastewater settings. This urban water profiling approach produced spatiotemporal information on pathogens, metagenomics, analytical chemistry as well as hydrological modelling in the Eerste- and Plankenbrug river system and the Stellenbosch wastewater treatment works over a period of two years. This information can be used for ecological health risk assessment and machine learning for the prediction of future health- and chemical risk stressors. – Dr Edward Archer

is coordinated and performed by Dr Edward Archer from the Department of Microbiology and analytical technical assistance provided by Prof Marietjie Stander and Mr Erick van Schalkwyk at the Stellenbosch University Central Analytical Facility (CAF) Mass Spectrometry Unit.



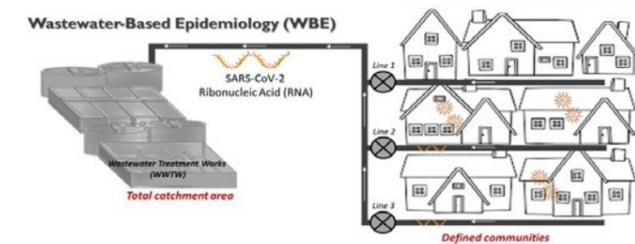
Example of results that were recorded at selected wastewater treatment works (WWTW) in the Cape Town and Stellenbosch region for communal illicit drug use trends using wastewater-based epidemiology (WBE).

### COMMUNITY-WIDE SUBSTANCE ABUSE PROFILING USING WASTEWATER-BASED EPIDEMIOLOGY

This annual surveillance program includes a seven-day profiling of illicit drugs and other pharmaceutical compounds at selected wastewater treatment works (WWTWs) in the Cape Town and Stellenbosch region using a wastewater-based epidemiology (WBE) approach. The results of the annual survey are reported to the Monitoring Centre for Drug and Drug Addiction's Sewage CORE analysis group in Europe (SCORE). The SCORE network consists of 34 laboratories and evaluates the results from 114 WWTWs in 100 cities. The research group of Prof Gideon Wolfaardt (Microbiology) is currently the only African partner in this global network. This WBE approach can provide valuable information on communal use and abuse of chemical substances. The utility of this method was highlighted by the observation of a significant decline in recreational drug use at the onset of the national COVID-19 lockdown period, compared to the same period in the previous year. The program

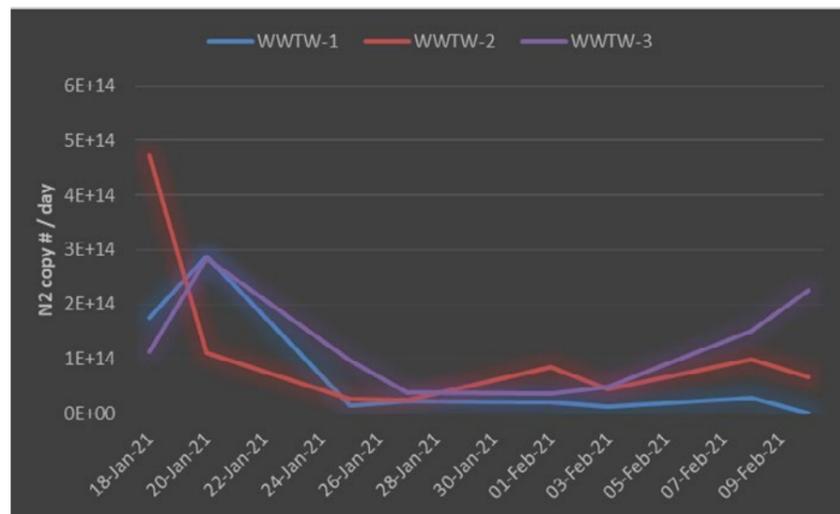
### BUILDING AN EARLY WARNING SYSTEM FOR COMMUNITY-WIDE INFECTIOUS DISEASE SPREAD: SARS-COV-2 TRACKING IN AFRICA VIA ENVIRONMENT FINGERPRINTING

This project involves the use of wastewater-based epidemiology (WBE) for the surveillance of SARS-CoV-2 infection in communities. This approach captures both symptomatic and asymptomatic individuals and thus serves as an added surveillance resource to trace the spread of infection in a community.



Schematic of the wastewater-based epidemiology (WBE) concept for community-wide identification of SARS-CoV-2 biomarkers.

Weekly surveillance of SARS-CoV-2 RNA fragments at selected wastewater treatment works (WWTWs) was performed in Cape Town/Stellenbosch, Lagos (Nigeria) and Bath/Bristol (United Kingdom) to track current infection hotspots and identify future outbreaks. In addition, routine weekly sampling in sewer lines originating from various locations such as student residences, centres, and office buildings at SU's Tygerberg Medical Campus, revealed positive signals at the onset of the second wave of COVID-19 infections in South Africa, before any clinical identification of infection was recorded. The Stellenbosch University research team include Prof Gideon Wolfaardt (Microbiology), Prof Wolfgang Preiser (Virology/NHLS Tygerberg), Dr Edward Archer (Microbiology), Ms Noluxabiso Mangwana (Microbiology/SAMRC) and Mr Ludwig Brocker (Microbiology).



Example of daily load estimation of SARS-CoV-2 RNA fragments at the influent of selected wastewater treatment works in Cape Town/Stellenbosch.



Mr. Stephan Nortje performing sampling in sewer manholes at the SU Tygerberg medical campus. Photo: Stephan Nortje

### UNRAVELLING THE PHYSIOLOGY OF A NOTORIOUS PATHOGEN

The research group of Prof Alf Botha is studying the physiology of an opportunistic fungus, *Cryptococcus neoformans*, which is the cause of numerous deaths among people suffering from HIV/Aids in South Africa. The goal of this research is to lay the foundations for the effective treatment of the mycosis caused by this fungus. During 2020, two PhD students published their findings on physiological changes that occur within *C. neoformans*, while growing in adverse conditions, similar to what the fungus is subjected to within its natural environment. Caylin Bosch found evidence that low nitrogen concentrations increase both cellular ergosterol levels and capsule thickness in *C. neoformans*. The latter is a known virulence factor of the fungus. Furthermore, she demonstrated that low nitrogen conditions also increase the tolerance of *C. neoformans* to the antifungal drugs, amphotericin B and fluconazole. The latter are commonly used to treat HIV/Aids

patients. Barbra Toplis found evidence that the urease enzyme of *C. neoformans*, previously thought to be only important for the degradation of urea occurring in the natural environment, also plays a pivotal role regarding the functioning of key metabolic pathways within the yeast cell. These findings put us one step closer to understand the pathogenicity and antifungal tolerance of this notorious pathogen. – Prof Alf Botha

### RESEARCH FOR THE BIOTECHNOLOGY INDUSTRY

During the annual prestigious Innovation Awards ceremony in December 2020, hosted by Stellenbosch University's technology transfer company Innovus, certificates were awarded to inventors who were granted patents during the year. Of the 18 patents granted to inventors across all faculties and departments at Stellenbosch University, four were awarded to inventors in the

Department of Microbiology. The names of the four patents and the grantees are: "Systems and methods for the detection of biomolecules" granted to Leon Dicks, Willem Perold, Deon Neveling and Thomas van den Heever; "A device for the detection of biomolecules" granted to Christiaan Viviers, Willem Perold, Leon Dicks and Giles Maybery; "Recombinant yeast" awarded to Rosemary Cripwell, Willem Van Zyl and Shaunita Rose; "Use of *Papiliotrema laurentii* as a bio-fertiliser" awarded to Leandra Moller, Alexander Valentine and Alfred Botha.

Of the five new spinout companies established by Innovus during December 2020, one named Immobazyme™ has close ties with the Department of Microbiology. One of the founders of this biotechnology company, Dominic Nicholas, is an MSc student in the laboratory of Prof Leon Dicks.

Immobazyme is a proudly South African and Stellenbosch-based biotech company founded by Dominic Nicholas, Ethan Hunter (MSc student in Plant Biotechnology) and Nicholas Enslin (MSc student in Plant Biotechnology). The company utilises innovative technologies, along with an environmentally responsible outlook, to develop disruptive enzyme-based solutions to global problems. Immobazyme is currently developing enzyme-based solutions for the South African sugar industry to reduce the burden of contaminating gums in their processing stream, carbon capture platforms to aid in the fight against climate change and novel medical devices to reduce wound infections

The Immobazyme team was fortunate enough to take part in Launch Lab's eight-week-long design thinking program, Countdown. Using skills training in design thinking, customer discovery and product prototyping, the program equips potential start-ups with the knowledge for answering the vital question, "I have an idea, but is it a business?". It further presented the team with the opportunity to receive hands-on mentorship from the director of innovation at LaunchLabs, Brandon Paschal.

Upon finishing the program, Immobazyme received the award for "Best Newcomer" alongside a memorable review from Brandon: "The Immobazyme team has been a model company to work with.

They have been able to build a great reputation with quality partners, and I look forward to watching their success unfold in the coming years".



The Immobazyme team receives their award for "Best Newcomer" after completing LaunchLab's Countdown business development program. From left to right, Nick Enslin, Dominic Nicholas, Ethan Hunter and Brandon Paschal.



Nick Enslin, chief technical officer of Immobazyme, stands next to their newly assembled bioreactor and rotating bed reactor.

## RESEARCH ACTIVITIES

**Prof Wesaal Khan** was an invited speaker at the ISME #UnityInDiversity virtual conference hosted from 11 to 12 November 2020. Top microbial ecologists from around the world were invited to the international symposium to showcase their research. She also formed part of the organising committee of the second South African World Health Organisation World Antimicrobial Awareness Week virtual symposium titled, “Antimicrobials: Handle with care”. The virtual symposium was jointly hosted by the Faculty of Health Sciences at the University of Johannesburg, the Water Research Commission of South Africa, North-West University and the Department of Microbiology at Stellenbosch University from 19 to 20 November 2020.

**Dr Edward Archer** did a poster presentation at SETAC-Europe SciCon 2020 virtual conference in May 2020 titled “Temporal profiling in a South African urban surface water setting: Using a multi-faceted approach towards investigating emerging health challenges”. He also did an oral presentation at the Water Research Commission World Environmental Health Day 2020 Webinar on 23 September 2020 titled “Using wastewater surveillance for forensic intelligence: monitoring substance abuse”. Dr Archer did an oral presentation at the Water Institute of South Africa (WISA) 2020 virtual conference from 4-7 December 2020, titled “Quantification and mass loading for contaminants of emerging concern from Western Cape wastewater treatment plants”.

**Dr Marelize Botes** did an oral presentation at ICON WASTEC project in collaboration with Fraunhofer SysWasser. This took place during the midterm meeting on 26 November 2020 and the title of her presentation was “How does electrochemical disinfection improve the water quality for agricultural use in SA”.

**Prof Alf Botha** is a member of the editorial board of *FEMS Yeast Research* (2008 – present); editor of the *Canadian Journal of Microbiology* (associate editor since 2011).

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

**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).

## ACADEMIC AFFAIRS

The Department of Microbiology has a large postgraduate student cohort. During 2020, there were 14 BSc Hons, 26 MSc and 20 PhD students registered. All the honours students successfully completed their studies, while five PhD students graduated during the year.

The Department of Microbiology was able to swiftly move to online teaching to ensure students could continue their studies during the COVID-19 epidemic of 2020. Midway through the semester, all teaching moved from face-to-face teaching to remote asynchronous teaching and learning, lately termed Emergency Remote Teaching, Learning and Assessment (ERTLA). With an unconditional commitment to putting in extra hours and working and supporting each other, the department’s lecturers adapted and executed ERT smoothly with great success. Dr Heinrich Volschenk co-authored the chapter ‘Responding to the necessity for change: Higher Education voices from the South during the COVID-19 crisis’ in the book *Responding to the necessity for change*.

## AWARDS TO STAFF AND STUDENTS

The Rand Water Chair in Public Health was awarded to Prof Gideon Wolfaardt for a five-year term starting on 1 July 2020. The proposed research chair was presented to Rand Water on 27 July 2020 and the five-year action plan was presented on 27 August. The first Advisory Board meeting took place on 9 February 2021. One PhD project will commence in 2021.

MSc student Dominique F Rocher was accepted for the prestigious JICA ABE Initiative Programme at the University of Tsukuba in Japan, from October 2020 to September 2022. She will be working in the Bioresources Engineering Laboratory under the supervision of Prof Zhongfang Lei, investigating a method to improve methanation of seaweed. She is also part of the SUSTEP program, which focuses on the study of sustainable science, technology and policies in various fields. Her research focuses on sustainable waste management and environmental policies relating to waste generation. The aim is to work with an energy resource and how to sustainably utilise waste products. In this instance, how to improve current seaweed technologies in South Africa.

PhD student MW Myburgh was accepted for a co-tutelage doctoral degree, i.e. registered at both Stellenbosch University and Padua University, Italy. This is the result of a long-standing collaborative relationship between the research groups of Profs Willem Heber Van Zyl and Marinda Viljoen-Bloom from SU and Prof Lorenzo Favaro from the University of Padova.

## STAFF MATTERS

**Mrs Louisa van der Westhuizen** provided valuable support for lecturers regarding undergraduate practical classes during her long career at the department. She retired at the end of 2019.

## A TRIBUTE TO PROF DOUG RAWLINGS

**Emeritus Professor Doug Rawlings** passed away in 2020. He joined Stellenbosch University in 1998 and served as HOD of Microbiology until 2012. His main research interest was the molecular biology of acidophilic bacteria used in the mining industry, for which he was recognised as a world leader in the field. He was fascinated by the biology of plasmids, particularly the broad host range plasmids native to acidophiles, and published numerous papers in specialist plasmid journals and presented together with his students at many international Plasmid Biology meetings. Such was his love for plasmids that he completed a DSc in 2014 on the subject.

He maintained an NRF A-rating spanning almost three decades, and his research remained at the forefront of the bio-mining and bioleaching techniques developed by Gencor and BHP Billiton in the 1980’s, that South Africa was instrumental in developing and “exporting” to places such as Australia, Ghana, and Chile.

**Prof Rawlings** was mentor to many students and early-career scientists in the fields of bioleaching, acidophiles, and plasmid biology both locally and internationally. At Stellenbosch he graduated four PhD and nine MSc students, and numerous honours students.



Prof Doug Rawlings. Photo: Heinrich Volschenk

## SOCIAL IMPACT

Academic staff were invited for radio talks on a regular basis on relevant news topics.

## STATISTICAL INFORMATION

## Funding

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)  
European Commission Horizon 2020  
FirstRand Foundation  
Fraunhofer-Gesellschaft  
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  
Water Research Commission  
Western Cape Government,  
Environmental Affairs and Development Planning  
UKRI GCRF/Newton Fund Agile Response call to address COVID-19  
EPSRC/GCRF Global Challenges Research Fund  
Fraunhofer Alliances  
First Rand  
Rand Water  
Central Analytical Facilities (CAF), Stellenbosch University

**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	Dr H 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

**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

**Affiliated:**

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

**Support staff:**

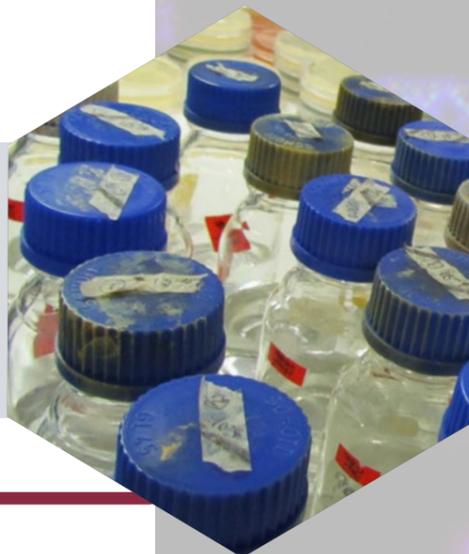
J Daniels  
 LJ Daniels  
 J de Kock  
 M Gey van Pittius  
 M Stuurman  
 T van der Merwe  
 W Wentzel

**Postdoctoral fellows and researchers:**

Dr Edward Archer  
 Dr Elanna Bester  
 Dr Kim Bester  
 Dr Marelize Botes  
 Mnr Casper Brink  
 Dr Rose Cripwell  
 Dr Shelley Deane  
 Dr Thando Ndlovu  
 Dr Shaunita Rose  
 Dr Wendy Stone  
 Mrs Lisa Warburg

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# DEPARTMENT OF PHYSICS

**RESEARCH INTERESTS**

**Theoretical Physics**

Condensed matter; Soft condensed matter and biophysics; Solitons in field theory and particle physics; Quantum phase transitions and exceptional points; Non-commutative quantum mechanics and field theory.

**Nuclear Physics**

Nuclear structure and interactions; Structural properties on the atomic nuclear and fundamental interactions within the nucleus; Nuclear techniques and technologies to study nuclear radiation in the environment; Nuclear radiation in the medical and health sector; Nuclear clustering phenomenon in light and heavy nuclei; Pygmy resonance within nuclei; Fundamentals of single particle properties on nucleons inside a nucleus; Co-linear cluster tripartition mode in ternary fission; New radiation detector technologies.

**Laser Physics**

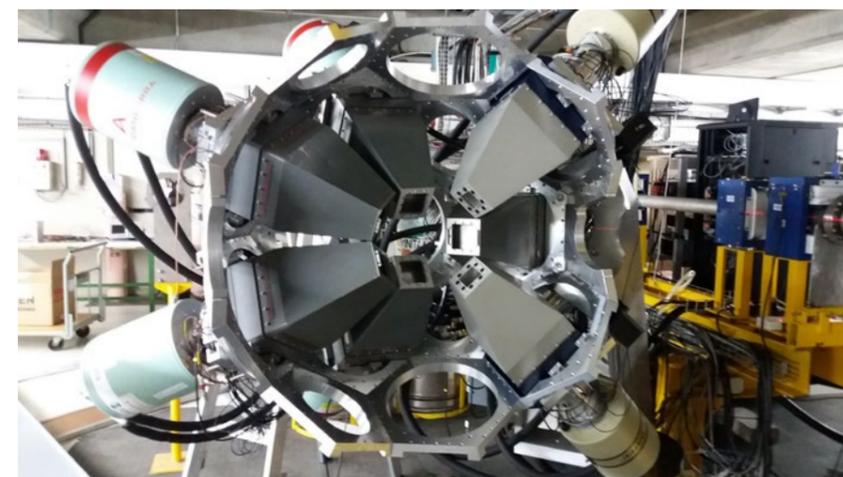
Quantum light-matter interactions; Quantum information processing with light; Quantum sensing Closed loop quantum control and quantum simulation using trapped ions; Transient absorption spectroscopy; Super resolution microscopy; Terahertz sources and spectroscopy; Laser pulse shaping for microscopy; Nonlinear spectroscopic and imaging techniques; Resonant ionisation spectroscopy and ion beam production; Laser-based additive manufacturing and X-ray tomography.

**RESEARCH HIGHLIGHTS**

**NUCLEAR PHYSICS**

**PHD-GRADUATE LUCKY MAKHATHINI APPOINTED AT ITHEMBA LABS**

As part of the ongoing GAMKA (Gamma-ray spectrometer for Knowledge in Africa ) detector array design and construction, Mr Lucky Makhathini, who has recently completed his PhD degree at Stellenbosch University, has been appointed as the instrumentation engineer at iThemba LABS. The detector array frame, referred to as the soccer ball, was designed by Prof Paul Papka to hold the GAMKA detectors and was commissioned during experiments at iThemba LABS. GAMKA 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.



A new detector arrangement for the GAMKA project showing the spherical vacuum chamber surrounded by six BGO shields that encapsulate the High Purity Germanium detectors.

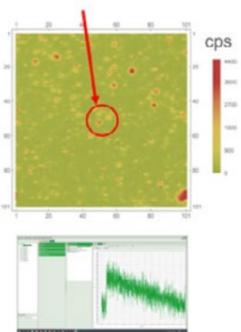
**Laser Physics**

**Quantum Nanophotonics**  
The Quantum Nanophotonics research group of Prof Mark Tame, holder of the SARChI chair in Photonics, Ultrafast and Ultra-intense Laser Science, made several significant advances during 2020.

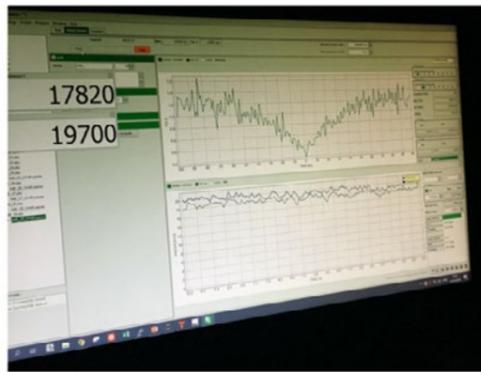
They achieved single-photon emission from nitrogen vacancy (NV) centres. Single photons are important for realising applications in quantum information processing, e.g. quantum computing, quantum communication and quantum sensing.



nanodiamond with NV centre



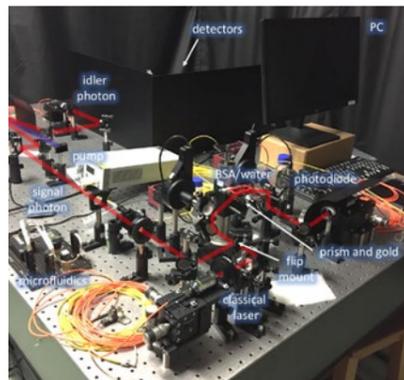
lifetime ~10ns



Second order correlation,  $g^{(2)}(0) = 0.2$  – single-photon regime

Characterisation of the light emission from a nitrogen vacancy centre. The single-photon regime is confirmed with a  $g^2$  value below 0.5.

They also demonstrated a quantum advantage for biosensing. They showed that by using quantum states of light one can make more precise measurements of biological interactions than is currently possible. This has important applications in biochemistry and medical diagnostics.



Quantum biosensing: the setup is used to probe biological interactions using quantum states of light. This enables a higher precision in the measurement.

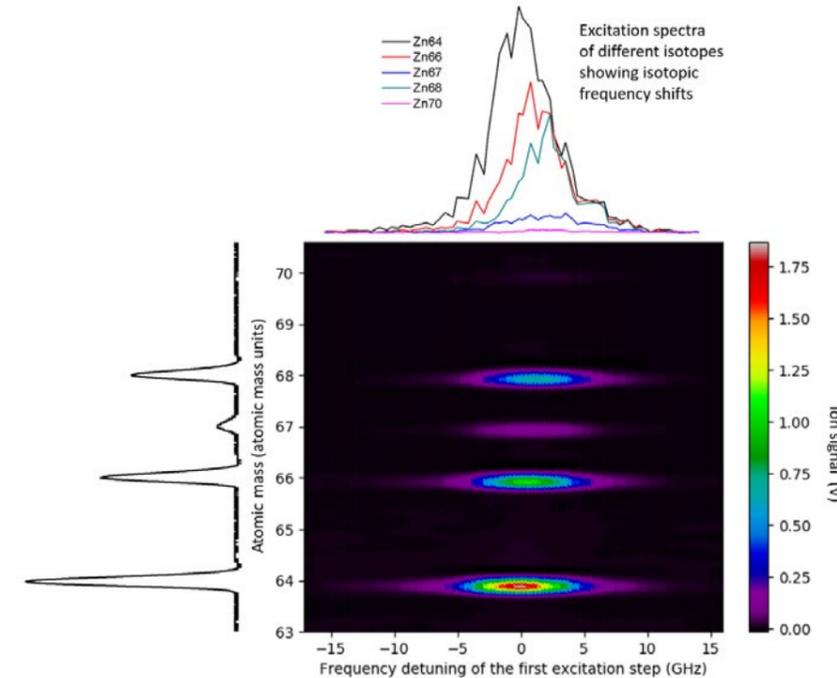
**FEMTOSECOND FREQUENCY COMB FOR THE LASER RESEARCH INSTITUTE**

The Laser Research Institute received a femtosecond frequency comb donated by the National Metrology Institute of South Africa (NMISA). The frequency comb was previously used as a frequency standard and will now be adapted for high resolution spectroscopy. It is the only system of its kind in the country.

**LASER-BASED TECHNIQUES FOR THE PRODUCTION OF PURE ISOTOPE SAMPLES**

In the high-resolution spectroscopy lab the first mass spectra of resonantly ionised zinc atoms were measured. The

ionisation is element specific, and for each laser pulse a full mass spectrum showing the five stable zinc isotopes is measured (see image below). The apparatus was developed in-house during the past three years, supported by the CSIR National Laser Centre Rental Pool Programme. The research is aimed at the development of laser-based techniques for producing pure isotope samples for medical use.



A two dimensional graph showing how strongly zinc atoms with different masses (vertical scale) interact with laser light of different frequencies (horizontal scale). This measurement technique has application in measuring the atomic masses in a sample and separating the atoms with different masses for use in medical diagnostics and treatment.

The graphs are the combination of many measurements using three laserbeams to ionise zinc atoms in a selective way and then measuring the masses of the ions. The apparatus has been developed by PhD students André de Bruyn and Frederick Waso, under supervision of Dr Christine Steenkamp. Currently this equipment is suitable to separate zinc atoms from atoms of other elements it may be mixed with. If we would have one laser with a smaller frequency bandwidth (purer colour) the apparatus will be suitable to separate the different isotopes of zinc.

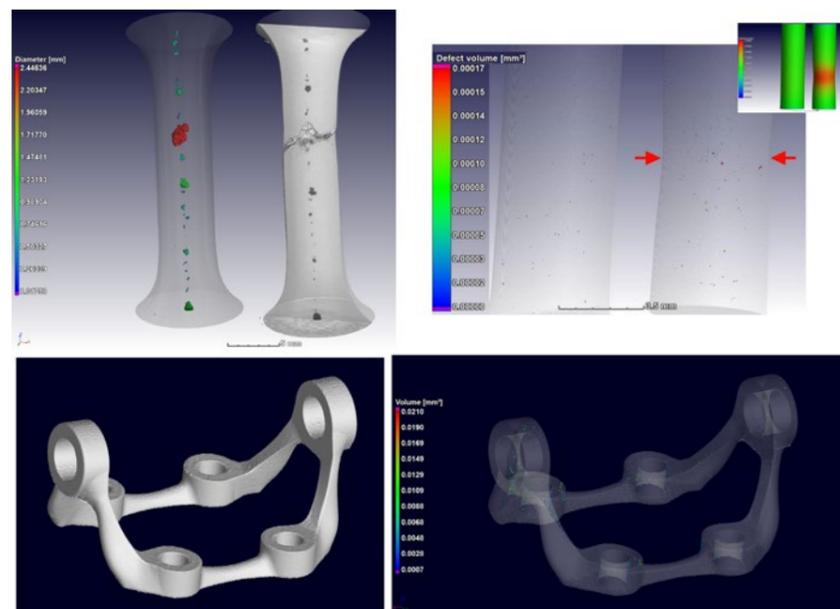
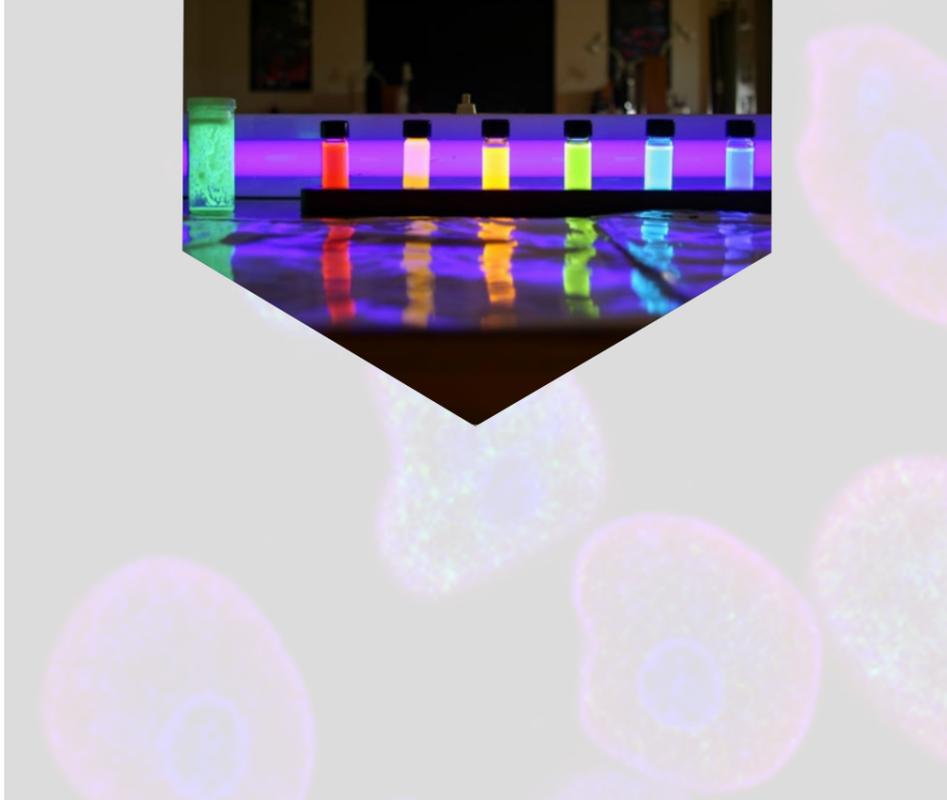
This basic principle of separation of isotopes is not new, but using this method to produce isotopes that can be processed into radiopharmaceuticals for medical scans and therapy is an emerging field worldwide and is new

in South Africa. This project is aimed to support the development of the planned South African Isotope Facility at iThemba Labs where novel radioisotopes will be produced in future for improved cancer detection and treatment. However, our first application on zinc is relevant itself as two of the isotopes of zinc are used in pure form to produce gallium-68 and gallium-67 that are the most important isotopes used for medical scans (PET and SPECT scans respectively).

We are currently separating the isotopes in time, but they still end up at the same spot. We are working on separating them in space too so that they can be collected individually, using a simple setup with no water cooling or moving parts. We hope to apply this method in a few years' time at iThemba LABS for producing pure samples of radioactive isotopes for applications.

**Understanding the effects of defects on mechanical properties in 3D printing**

The 3D Innovation research group of Prof Anton du Plessis, with collaborators Profs Ina Yadroitsev and Igor Yadroitsev from the Central University of Technology, Bloemfontein, used X-ray tomography to improve our understanding of the effects of defects on mechanical properties in metal additive manufacturing. The use of X-ray tomography to visualize pores in parts (non-destructively) prior to mechanical testing has allowed us to improve our understanding of the effect of this porosity on the mechanical properties of the part (also referred to as “effect of defect”). This can provide the possibility to discriminate critical defects from harmless ones, and thereby build confidence in additive manufacturing processes.



Shown here are different studies where the 3D imaging of defects is used before and after mechanical testing to evaluate the relative location of failure (at largest pore in top left) and identify deformation and pore coalescence (top right). The bottom image shows a topology optimised “biomimetic” bracket manufactured by additive manufacturing in titanium alloy, the image to the right shows the location of specific defects in this bracket, which helps to evaluate and predict the performance of this part for its intended use. Images published in Du Plessis, A., Yadroitsava, I. and Yadroitsev, I., 2020. Effects of defects on mechanical properties in metal additive manufacturing: A review focusing on X-ray tomography insights. *Materials & Design*, 187, p.108385.

**RESEARCH ACTIVITIES**

**Mr Gary Andrews** received a FIRLT grant to develop a standardized introductory text for the physics module in the Extended Degree Program (EDP). These notes are now available in isiXhosa, Afrikaans and English, and will be accompanied by short explanatory videos, also in all three languages. In this regard he is assisted by MSc student in physics, Mr Abbey Maheso.

**Dr Gurthwin Bosman** received an African Laser Centre Africa collaboration grant to work with former alumnus, Dr Neway Tegegne, now at Addis Ababa University, Ethiopia. During 2020 Dr Tegegne’s visit to Stellenbosch to conduct measurements on the ultrafast laser system had to be cancelled. Regardless of this setback, the researchers involved produced a research article entitled ‘Light-induced degradation of a push-pull copolymer for ITO-free organic solar cell application’, published in the *Journal of Materials Science*.

**Prof Anton du Plessis** holds editorial positions in the journals *Additive Manufacturing*, *Material Design and Processing Communications* and *Scientific African*. He is also a member of the editorial boards of the journals *3D Printing and Additive Manufacturing*, *GigaByte journal* and *Research in Nondestructive*

*Evaluation*. He has an adjunct faculty position at Nelson Mandela University’s Faculty of Engineering. He was invited as a speaker at the ASTM International conference on Additive Manufacturing, November 2020, virtual as well as at the Additive Manufacturing Meets Medicine Conference, September 2020, both which took place virtually. He was elected onto the managing board of the International Association for Computed Tomography for 2020-2022.

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

**Dr Pieter Neethling** is interim chairman of the Photonics Division of the South African Institute of Physics and director of the Laser Research Institute (LRI). Together with Prof Erich Rohwer they started a new contract research project for the Institute for Maritime Technology to use LIDAR for detecting drones.

As coordinator for SAINTS (Southern African Institute for Nuclear Technology and Sciences), **Prof Richard Newman** was the main organiser of the SAINTS@tlabs Physics Summer School in January 2020 and the SPAMS (Spectrum, Presentation, Analysis, Manipulation and Simulation) Workshop on Spectral Analyses during March 2020.

**Prof Erich Rohwer** and **Dr Pieter Neethling** started with a new project with Prof Thomas Feurer of the Department of Applied Physics at Bern University on Time domain CARS which is based on time domain ptychography principles, developed by this group. He also collaborated with Dr Gurthwin Bosman and Dr Peter Baricholo from the National University of Science and Technology in Zimbabwe to do research on fibre lasers. The research is supported by the African Laser Centre (ALC).

He participated in the 25th International Commission of Optics (ICO) and 16th OWLS (Optics within Life Science) conference which took place in Dresden from 31 August to 4 September 2020. He served on the organising committee of the OWLS Conference and submitted a paper. This conference has been postponed until 2021.

Members of the Laser Research Institute, Prof Erich Rohwer, Dr Pieter Neethling

and Dr Gurthwin Bosman, are involved in research on Ptychographic pulse compression applied in non-linear microscopy. This development aims to improve signal to noise ratios in non-linear microscopy applications with reduced thermal damage to biological materials. It is endeavoured to obtain chemically specific information of molecules inside cells using a simple femtosecond laser based microscopy system, running at 50 MHz. The work will find application in the development of affordable medical diagnostic microscopy tools.

In collaboration with the SU Language Centre **Dr Phillip Southey** gave an oral presentation on ‘Interpreting science: Discoveries in translation’ at the SOTL (Science of Teaching and Learning) conference at SU. He presented at the online seminar on qualitative analysis for the Scholarship of Educational Leadership Course. He is also part of the Physics and Astronomy Education Research Group.

**Prof Frederik Scholtz** has an ongoing collaboration with BIUST (Botswana International University of Science and Technology) with two papers published in 2020 and another paper under review with researchers from the S.N. Bose National Centre for Basic Sciences. Prof Scholtz refereed papers for the journals *Physical Review Letters*, *Physical Review C&D*, *Physics Letters A*, *European Journal of Physics* and *European Physics Letters*.

**Prof Mark Tame** took an active role in the NRF’s National Working Group on Quantum Technologies. He helped draft a roadmap for South Africa’s investment in quantum research over the next decade. He refereed papers for the international journals *Scientific Reports*, *Nano Letters*, and *Laser and Photonics Reviews*, as well as for the NRF’s Competitive Programme for Rated Researchers (CPRR) grant applications. He also continued as an editorial board member for the international journal *IOP Journal of Optics*. He worked on the Technical Program Committee of Metamaterials 2021. He also published two papers in *Physical Review A* and one book chapter in Elsevier.

**Dr JJ van Zyl** was an invited speaker at the 10th Tastes of Nuclear Physics conference about timely topics in Nuclear Physics and Nuclear Astrophysics, hosted and organised by the University of the Western Cape (UWC) between 30 November and 4 December 2020.

His presentation was “Implementation of digital DAQ system for coincidence (p,α) scattering experiments”. He reviewed two research proposal applications for the NRF’s Competitive Programme for Rated Researchers (CPRR), namely that of Dr Retief Neveling (Proton Decay Studies with Cake and the K600) and Dr Jacques Bezuidenhout (The Use of Natural Radionuclides to Investigate Sedimentation Processes).

**Prof Herbert Weigel** was invited to present at two international conferences, which were then cancelled due to the Covid-19 pandemic. The international collaboration between Prof Weigel and Prof Noah Graham from Middlebury College (USA) continued and produced a publication deriving a technique to compute quantum corrections to vortex systems. Prof Weigel wrote an invited review paper on “Nucleon structure functions”, with former student Dr I. Takyi, now at the Kwame Nkrumah University in Ghana.

The first South Africa-JINR (Joint Institute for Nuclear Research) workshop on co-operation between theoretical physics environments in South Africa and Russia was hosted by **Prof Shaun Wyngaardt** at the Le Franschhoek hotel in Franschhoek from 25 to 28 January 2020. The event was attended by theoretical physicists from various institutions in South Africa, including Stellenbosch University, the University of Cape Town, UNISA, University of Johannesburg, the Square Kilometer Array, Nelson Mandela University, the South African Astronomical Observatory, and the University of the Western Cape.

Prof Wyngaardt organised the third workshop for developers of the virtual laboratory for Nuclear Physics at Stellenbosch University’s main campus. The workshop was attended by staff and students of SU’s nuclear physics division, the University Centre of the Joint Institute for Nuclear Physics, the Intergraphics LLC Company in Dubna, Russia and DRiVE Pty (Ltd) in South Africa. He also co-hosted the 10th “Tastes for Nuclear Physics” school. The event was the first virtual school of its kind in Africa and attended by more than 800 physicists from across the world.

## ACADEMIC AFFAIRS

The Department of Physics delivered eight BScHonours, six MSc and eight PhD graduates during the 2020 academic year. The academic year was dominated by the collective and successful effort by all members of the Department to switch to the Emergency Remote Teaching, Learning, and Assessment approaches necessitated by the pandemic. The period of closure and limited access to research laboratories has led to some delays in experiments, with good progress occurring since.

## AWARDS TO STAFF AND STUDENTS

Mr Conrad Strydom received the Meiring Naudé prize for the best BScHonours student in Physics in 2020, as well as the Rector's Award for Excellent Achievement. Ms Emma King, a BScHons student in Physics, was the joint recipient of the Dean's Medal in 2020 for her achievements the preceding year. Prof Herbert Weigel was rewarded as Distinguished Referee by European Physical Journals.

## STAFF MATTERS

Prof Hans Eggers, professor in theoretical physics, retired in March 2020. Prof Paul Papka, associate professor in nuclear physics, and Prof Michael Kastner, professor in theoretical physics, resigned. Ms Colleen April, administrative officer, retired in February 2020. Dr Anslyn John joined the Department of Physics as a lecturer. His fields of interest are general relativity, cosmology, and fluid mechanics.

## SOCIAL IMPACT

Dr JJ van Zyl again hosted a class of Die Wingerd Pre-Primary School in Somerset Wes on 11 December 2020. Given the COVID-19 restrictions the event was hosted in the 1st Somerset West Scouts Hall in Somerset West. The children, ages 5-6 years, were entertained with fascinating science demonstrations, played a laser obstacle course and built a simple working electric motor.

The Department of Physics hosted the annual Women in Physics meeting as a virtual Zoom event. This provided the opportunity to include international postgraduate student speakers. Participants were asked to send photos of themselves where they are portrayed as a person and not as a physicist as part of the welcome slide. Students shared their experiences and how they got to where they are now in brief 10-minute talks. The topics included the following: Experiences of being a woman in different research environments; Choosing research topics and supervisors; Building self-confidence; Imposter syndrome, followed by discussions and questions. Attended by 17 participants, the event provided an opportunity to build connections and networks. The event aimed to increase interaction between the female undergraduate and postgraduate students of the department, to share experiences, and provide a platform for women in physics to encourage and motivate younger students.

At the beginning of the year the OSA/SPIE Student chapter held an informal pizza evening to welcome back all the LRI students. On 4 June the Laser Chapter students held a virtual Quiz over MS-Teams.

The Stellenbosch Laser Student Chapter (SLSC) celebrated the International Day of Light on 16 May 2020 during lockdown. Due to the lockdown regulations an in-person event was not allowed, and replaced with a photo challenge to capture specific photographs as listed on a flyer, displaying certain phenomena and characteristics of light. Miss Nancy Payne was the overall winner.

The Department of Physics, together with the Departments of Medical Virology and Genetics, hosted a Nobel lecture evening on 28 October 2020, where the research behind the Nobel prizes in these three disciplines was explained in simple terms to a virtual audience of 60 staff members, students and the general public. The speakers were Dr Anslyn John, Department of Physics, Prof Gert van Zyl, Division of Medical Virology, and Prof Johan Burger, Department of Genetics.

## FUNDING

### South Africa

ARMSCOR – Virtual Defense Engagement Programme and Laser Defense Research Project (DESUP)  
Centre for Nuclear Safety and Security  
CSIR African Laser Centre  
CSIR National Laser Centre's Rental Pool programme  
CSIR/SU Research Chair in Quantum, Optical and Atomic Physics  
CSIR-DST Inter-Programme Postgraduate Bursary Support  
Institute for Maritime Technology (IMT)  
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 grant for development of a virtual laboratory for Nuclear Physics  
SA-JINR travel grant  
South African Institute for Physics (SAIP) under the Women in Physics in SA (WiPISA) project

### Europe

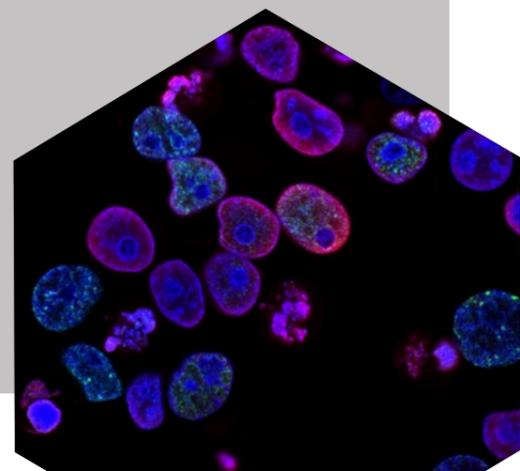
DAAD scholarships in Germany  
European Physical Society  
Federal Ministry of Education and Research (BMBF), Germany  
Newton Fund, Rutherford Appleton Laboratory  
NT-MDT Spectrum Instruments for conference contributions  
PicoQuant  
Wirsam Scientific International Centre for Theoretical Physics

### United States of America

Optical Society of America (OSA)  
International Society of Optics and Photonics (SPIE) for the Laser

## 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 localized energy densities, known as solitons or solitary waves. They have innumerable applications in physics, ranging from properties of subatomic particles via condensed matter phenomena to cosmological defects.
	Prof Mark Tame	Quantum nanophotonics which involves the study of light-matter interactions at the quantum level and has applications in quantum computing, quantum communication and quantum sensing.
	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)
	Prof Frederik Scholtz	Non-commutative quantum mechanics and quantum field theory
Established researchers	Prof Erich Rohwer	Laser development, laser techniques and applications, laser spectroscopy and microscopy
	Prof Anton du Plessis	Additive Manufacturing, X-ray tomography, Biomimicry
	Prof Paul Papka	Selection of light N=Z nuclei for which clustering has structural implications, with application in nucleosynthesis scenarios
	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	Condensed matter physics with a focus on interacting quantum systems and closed quantum systems out of equilibrium. I am interested in finding applications of methods such as continuous unitary transformations (CUTS) and algebraic techniques within this setting.
	Dr Pieter Neethling	Using linear and nonlinear spectroscopic techniques to address problems in solid state physics, biochemistry and chemistry

### STAFF LIST

#### Academic:

Mr Gary Andrews  
 Dr Gurthwin Bosman  
 Dr Daphney Bucher  
 Prof Anton du Plessis  
 Dr Anslyn John  
 Dr Hannes Kriel  
 Prof Kristian Müller-Nedebock (Departmental head)  
 Dr Pieter Neethling  
 Prof Richard Newman  
 Prof Erich Rohwer  
 Prof Frikkie Scholtz  
 Dr Philip Southey  
 Dr Christine Steenkamp  
 Prof Mark Tame (SARChI)  
 Prof Brandon van der Ventel  
 Dr JJ van Zyl  
 Prof Herbert Weigel  
 Prof Shaun Wyngaardt

#### Extraordinary Professors:

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

#### Professors Emeritus:

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

#### Support staff:

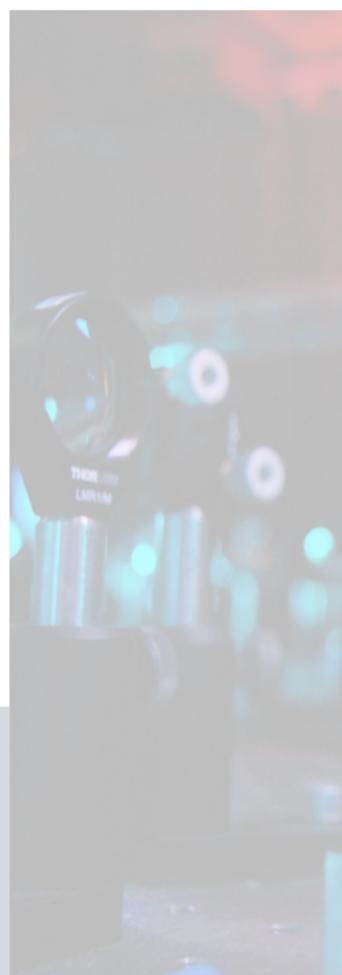
Mr Cashwall Pool  
 Ms Ursula Isaacs  
 Mr Stanley February

#### Technical staff:

Mr Tinus Botha  
 Mr Patrick Benting  
 Mr Philip Cornelissen  
 Mr Hugh Esterhuizen  
 Mr Johan Germishuizen  
 Mr Joshwine Gertze  
 Mr David Pool  
 Mr Eben Shields

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 Web: [www.sun.ac.za/physics](http://www.sun.ac.za/physics)



# DEPARTMENT OF PHYSIOLOGICAL SCIENCES

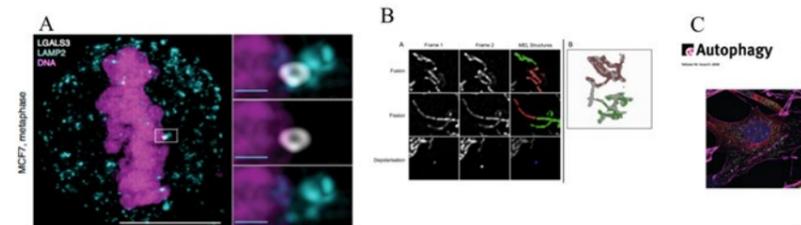
### RESEARCH INTERESTS

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

### RESEARCH HIGHLIGHTS

#### FROM THE AUTOPHAGY RESEARCH GROUP

Some of the research highlights during 2020 include publications revealing the localisation of damaged lysosomes using structured illumination microscopy (Figure 1A), published in *Nature Communications*. Our work on the development of a software tool to quantitatively assess mitochondrial fission, fusion and depolarisation (Figure 1B) was published in *PlosOne*, and a micrograph featured on the cover of the journal *Autophagy* (Figure 1C). – Prof B



(A) Damaged lysosomes detected using super-resolution structured illumination microscopy, published in *Nature Communications*. (B) Mitochondrial fission, fusion and depolarization events quantitatively and dynamically assessed, published in *PlosOne*. (C) Micrograph for the cover of the journal *Autophagy*, May 2020, showing a 4 colour SR-SIM micrograph. Images: Ben Loos

### COVID-RELATED RESEARCH

During 2020 the COVID-19 pandemic upended researchers all over the world. Early in 2020, Prof Resia Pretorius worked with Prof Douglas Kell from the University of Liverpool (UK) and Gene



Heyden, a retired nursing specialist from Spokane (United States) to write a paper on the usefulness of Lactoferrin as possible nutraceutical to be used in treatment of COVID-19. Researchers from the Department also teamed up with clinicians from Mediclinic Stellenbosch, Dr Jaco

Laubscher and Dr Johan Laurens, and Pathcare Laboratories' Dr Janami Steenkamp, to unravel the effects of COVID-19 on endothelial function (endothelial cells line the inside of blood vessels), fibrin(ogen) the main circulating clotting protein, platelets (small cells that assist with blood clotting), and red blood cells (the cells that carry oxygen in the blood). In June 2020, the first paper was published in the *International Journal of Molecular Sciences* followed by two more papers published in the *International Journal of Molecular Sciences* and *Cardiovascular Diabetology*.

The second paper investigated clotting propensity in patients with COVID-19, and compared results to healthy individuals and those with Type 2 Diabetes Mellitus (T2DM). T2DM patients were included in the study, as it is well-known that these individuals

are more prone to suffer from severe COVID-19 symptoms. In the third paper, the team studied platelet and red blood cell ultrastructure and circulating inflammatory biomarkers that are well-known to cause severe blood clotting in COVID-19 patients. It was published in the *International Journal of Molecular Science*.

We now understand the effects of COVID-19 more clearly, and the results support the findings from other research groups that suggest that severe coagulopathies (clotting abnormalities) are central to the disease severity. Consequently, the team concluded that the prevention of coagulopathies must lie at the heart of successful therapies. The researchers involved in the COVID-19 research project are Prof Resia Pretorius, Dr Chantelle Venter (researcher and technical officer), PhD student Jandr  Bezuidenhout and four BScHons students, Corlia Grobler, Siphosethu Maphumulo, Meirelle Grobbelaar and Jhade Bredenkamp. – Prof Reesia Pretorius

**LAUNCH OF SPINOUT COMPANY PHAGOFLUX**

In 2020, Prof Ben Loos was involved with the launch of a spin-out company called ‘Phagoflux’, in collaboration with founding members Prof Jannie Hofmeyr, Prof Willie Perold, Prof Pieter Fourie and Dr Andr  du Toit.

**RESEARCH ACTIVITIES**

**Prof Kathryn Myburgh** presented a poster during the virtual conferences of the American College of Sports Medicine in June 2020, and at the International Society for Extracellular Vesicles in July 2020. She is a Council Member of the Royal Society of South Africa, and holds the DSI/NRF’s South African Research Chair in Skeletal Muscle Physiology, Biology and Biotechnology. During 2020 she continued her collaborations with Dr O Loudig from the Meridian Centre for Discovery and Innovation in New Jersey (USA). She is also involved with a multi-national consortium of institutions, including the Universities of Stirling (Scotland), Copenhagen (Denmark), Ume  University (Sweden) and from South Africa the Universities

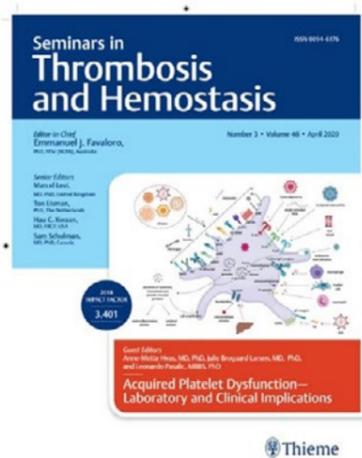
of Cape Town, Witwatersrand and Stellenbosch. Other collaborators are from the Hatter Institute of Cardiovascular Research and the Institute of Infectious Disease and Molecular Medicine at the University of Cape Town, as well as the Department of Immunology at the University of Pretoria and the Department of Biochemistry at the University of KwaZulu-Natal.

**Prof Ben Loos** attended the Crick African Network symposium from 4-6 March 2020, hosted by the East African Centre for Cell Biology of Infectious Pathogens (WACCBIP) at the University of Ghana, Accra.

**Prof Carine Smith’s** students presented their research (virtually) at the annual conference of the South African Neurosciences Society (SANS). Dr Yigael Powrie, a postdoctoral fellow, and BScHons student Janica Conradie were awarded second prize for their poster.

**Prof Resia Pretorius’s** research group published a record number of 14 research papers as part of their ongoing research efforts to investigate the pathophysiology of blood cells and abnormal clotting (hypercoagulation) in various inflammatory conditions. Two papers of the group were featured on the cover of the journal *Seminars in Thrombosis and Hemostasis*. The authors were Jandr  Bezuidenhout and Prof Pretorius, and for the second article Martin Page and Prof Pretorius.

She also presented a virtual keynote address at the EU-CardioRNA meeting in September 2020.



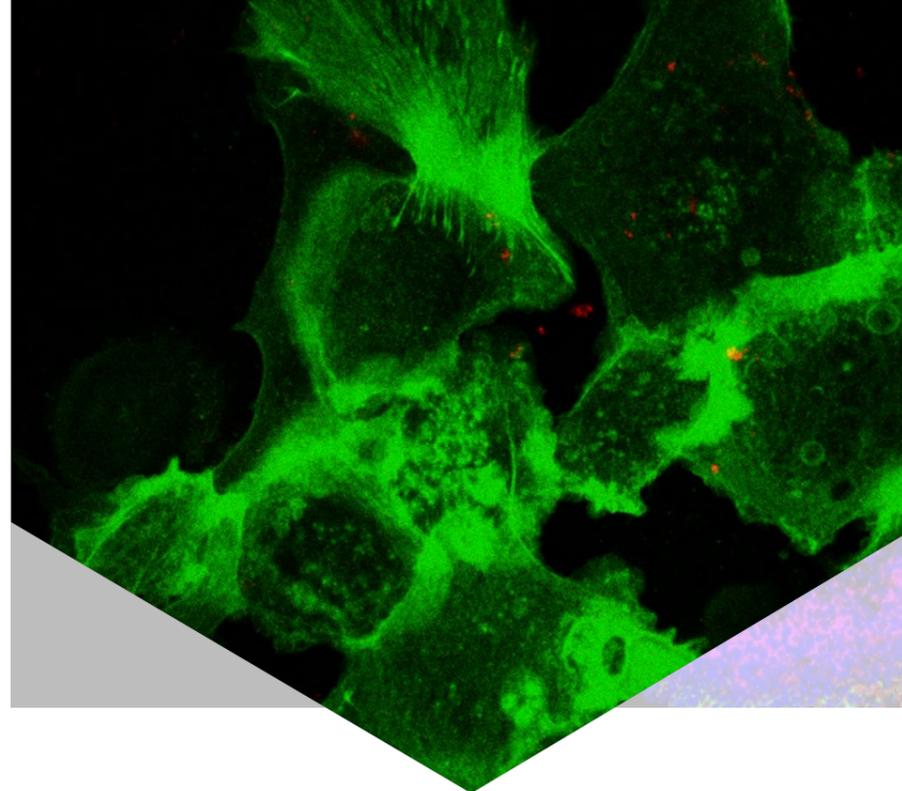
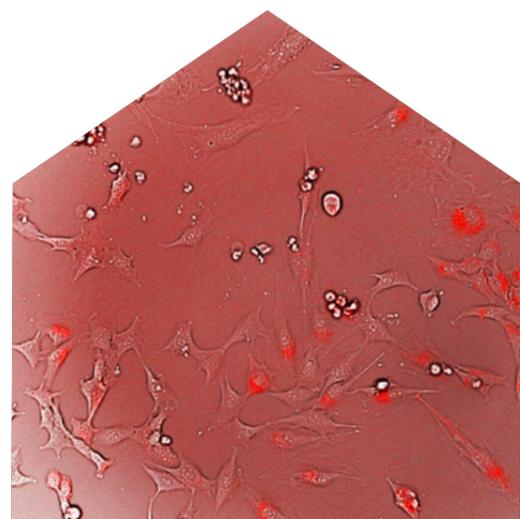
**SERVICE TO THE SCIENTIFIC COMMUNITY**

**Prof Kathryn Myburgh** is a member of the NRF Standing Committee for Health and Medical Sciences (HMS) and the Thuthuka Panel. She serves on the editorial boards of the journals *Medicine and Sciences in Sport and Exercise* and the *Journal of Muscle Research and Cell Motility*.

**Prof Ben Loos** serves on the editorial board of the journal *Autophagy*.

**Prof Anna-Marie Engelbrecht** serves on the editorial boards of the journals *Frontiers in Pharmacology* and the *International Journal of Biomedical Sciences*. She serves on the governing board and management committee of the African Cancer Institute (ACI), and on the management committee of the Institute of Biomedical Engineering (IBE).

**Prof Resia Pretorius** is a panel member of CardioRNA COST Action CA17129, a collaborative pan-European network of multidisciplinary researchers, clinicians, and industrial partners aiming to accelerate the understanding of transcriptomics in cardiovascular disease (CVD) and further the translation of experimental data into usable applications to improve personalised medicine in this field. She is a member of the scientific advisory board for the Phys2biomed project, a research programme funded by the European Union which investigates biomechanics in health and disease and the development of advanced physical tools for innovative early diagnosis.



**ACADEMIC AFFAIRS**

**Prof Anna-Mart Engelbrecht** was instrumental in the introduction of two new multi-disciplinary BSc programmes. The BSc in Applied Medicinal Chemistry includes Physiology, Chemistry, Botany and Patent Law, while the BSc-degree in Biomedical Mathematical Sciences includes the subjects of Physiology and Mathematical Sciences.

Prof Engelbrecht is also co-recipient of a Carnegie Fellowship with Prof Soraya Bardien from SU’s Faculty of Medicine and Health Sciences for the development of a Master of Science (MSc) programme in Applied Neuroscience at SU. An important component of the course will be the inclusion of a Precision Medicine and Neurogenomics component. This has been made possible by the involvement of two researchers from the University of Manitoba (Canada), namely Dr Galen Wright from the Department of Pharmacology and Therapeutics, and Prof Britt Dr gem ller, holder of the Canada research chair in pharmacogenomics and precision medicine.

**AWARDS TO STAFF AND STUDENTS**

**Prof Faadiel Essop** was awarded a prestigious TAU (Teaching Advancement at University) Fellowship that aims at advancing teaching quality and the professionalisation of teaching and learning in the public higher education sphere. His TAU fellowship project will focus on the notion that scientists/engineers often view their discipline as “neutral” and therefore devoid of any socio-political and historical contexts.

The Stellenbosch start-up company, BioCODE, received the best emerging company award from Innovus, the University’s technology company. **Prof Resia Pretorius** and **Prof Anna-Mart Engelbrecht** are both directors, together with Prof Willie Perold from the Faculty of Engineering. BioCODE was also the first recipient of funding to the value of R1.5million from the University Technology Fund (UTF)) and received significant media coverage. BioCODE was also a finalist in the Falling Walls Initiative during the Berlin Science Festival. Prof Pretorius also participated in the

University of Stellenbosch Business School’s Founder’s Forum Series on 27 August 2020. The theme of the panel discussion was “Entrepreneurship: It’s a woman’s world”.

**STAFF MATTERS**

Dr JADW Strauss retired in December 2020 after 35 year of service.

**SOCIAL IMPACT**

The “Science meets Art: Addressing stigma in illness” exhibition at the Rupert Museum, Stellenbosch, is a collaboration between **Prof Ben Loos’** research group and Prof Elmarie Costandius from the Department of Visual Arts. Local artists were commissioned to create artwork inspired by the research micrographs produced by postgraduate students and researchers in the Department of Physiological Sciences. The aim was to foster communication and engagement with topics such as mental illness, Alzheimer’s disease and cancer. Inclusion of isiXhosa nomenclature allowed entry to communication in a unique way.



At the launch of the 'Science meets Art' exhibition at the Rupert Museum in October 2020, from left to right, Nicola Heathcote, Kim Fredericks, Jurgen Kriel, Dr Tando Maduna, Prof Ben Loos, Elizabeth Miller-Vermeulen, artists Zacharia and Nomsa Mukwira, Tamryn Barron, Demi Pylman, Sinnead Cogill, Naomi Okugbeni, Dr Caroline Beltran, Prof Elmarie Costandius, Nsuku Nkuna and Robyn-Leigh Cedras-Tobin (director of the Rupert Museum).  
Photo: Tatum Cogan

**Prof Faadiel Essop** contributed several Op-Ed articles that were published in the *Mail* and *Guardian* and *News24*.

## STATISTICAL INFORMATION

## FUNDING

### South Africa

Department of Science and Technology  
National Research Foundation  
NRF-Knowledge Field Development Grant  
Technology Innovation Agency (TIA)  
University Technology Fund (UTF) grant

### Other

Carnegie Fellowship (USA)  
Royal Society (United Kingdom)

## NRF - RATED RESEARCHERS

Prof Faadiel Essop	B2	Cardio-metabolic research
Prof K Myburgh	B2	Biomedical Sciences
Prof B Loos	C1	Autophagy & Cell death
Prof C Smith	C2	Multidisciplinary stress biology
Prof E Pretorius	B3	Inflammatory blood biomarkers and blood coagulation

## STAFF LIST

### Academic:

Prof A-M Engelbrecht  
Prof MF Essop  
Prof B Loos  
Prof KH Myburgh  
Dr T Nell  
Prof E Pretorius (Departmental Head)  
Dr B Sishi  
Prof C Smith  
Dr JADW Strauss

### Extraordinary Professors:

Prof DB Kell  
Prof I Laher (University of British Columbia)

### Research Fellow:

Dr G Ellis

### Support Staff:

Dr D Joseph  
Dr A Krygsmann  
Dr C Venter  
Mrs G Simon  
Mr J Isaacs

### Post Doctoral Fellows:

Dr T Davis  
Dr A du Toit  
Dr T Maduna  
Dr Y Powrie  
Dr E Teer  
Dr G Van Niekerk  
Dr A DuP Van Staden  
Dr C Venter

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