2015
FACULTY OF SCIENCE ANNUAL REPORT

From the Dean

The Faculty of Science seeks to establish itself as a respected thought leader and knowledge partner in Africa and the international academic arena.

During 2015, it made great strides in its pursuit of this vision and Stellenbosch University's strategic priorities, with its staff and students excelling in numerous ways.

Research excellence

The year under review saw two new research chairs being added to the Faculty's existing nine chairs. They are the SARChI chair in Integrated Skeletal Muscle Physiology, Biology and Biotechnology, while collaborative efforts with the CSIR resulted in the implementation of a joint research chair in Quantum, Optical and Atomic Physics.

Several researchers managed to secure competitive grants from South Africa's National Research Foundation, the Volkswagen Foundation and the European Union.

The Faculty realises that excellence also requires collaboration in order to enhance its international visibility and publication quality and deepen research in areas where it lacks skills or infrastructure. In the reporting year, the Faculty collaborated with more than 700 institutions worldwide. Two of these collaborations, with bioinformaticians from the Katholieke Universiteit Leuven in Belgium and the University of London, resulted in two workshops for staff and students on next generation sequence analyses and statistics and methods in bioinformatics.

During 2015 a record number of 50 PhD and 150 Honours students graduated – the highest number of postgraduate students since 2011.

Several of our researchers received recognition for research excellence, with awards being made to Prof. Bert Klumperman (2015 SASOL Chemistry Innovator of the Year medal), Prof. André de Villiers (South African Chemical Institute's Raikes medal) and Prof. Delia Haynes (Jan Boeyens prize of the South African Crystallographic Society). The Havenga prize for life sciences, awarded by the *Suid-Afrikaanse Akademie vir Wetenskap en Kuns*, was awarded to Prof. Leon Dicks. Phd student Mr Ethan Newman received the NRF award for best next-generation male researcher.

Broadening access

The Faculty remains committed to educate an increasing number of young scientists in support of the South African government's initiative to create a knowledge society. By broadening access to the Faculty's teaching and research, including a more diverse group of students, the aim is to develop critical thinkers who will play an active role in the development of a successful multicultural South African society. The Faculty is therefore involved with recruitment actions and bursaries to top students from all population groups.

Various initiatives are being implemented to ensure excellent undergraduate teaching and student success. This includes differentiated student support and innovative teaching and learning strategies, such as the flipped classroom, blended learning and the intensive use of information and communication technology.

Societal impact

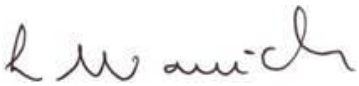
To give further content to the University's ethos of "science for society", our academic departments engaged in a number of social outreach activities, most notably the Department of Chemistry's chemistry outreach initiative SUNCOI, and the Department of Physics' celebration of the International Year of Light. Researchers also contributed to popular science magazines such as *Quest*, the online platform *Conversation Africa* and participated in our popular Science Café Stellenbosch events.

In conclusion

There is no doubt that 2015 was a tumultuous year for higher education institutions in South Africa. We are experiencing large scale changes with impacts on the local and global level.

While we are acutely aware of the impact of these events on our staff and students, I am proud to present this annual report as a testament to the exceptional people and students in this faculty who have managed to maintain high standards, a record postgraduate student output and a variety of awards for excellence in research.

I would like to make use of this opportunity to thank each and every one for their outstanding work ethos and diligence during 2015.



Prof. Louise Warnich
Dean: Faculty of Science
Stellenbosch University

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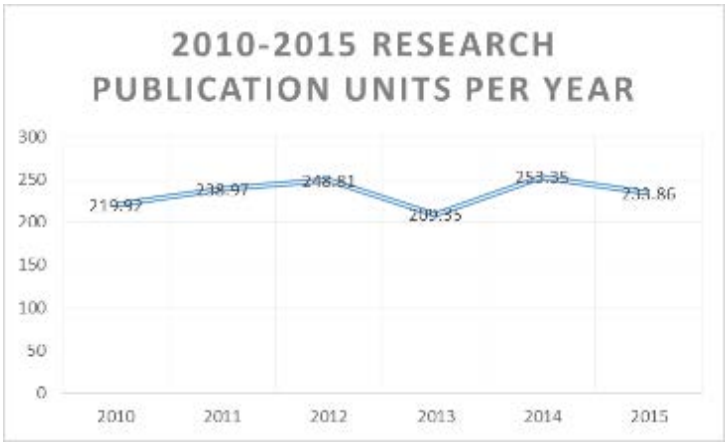
RESEARCH EXCELLENCE

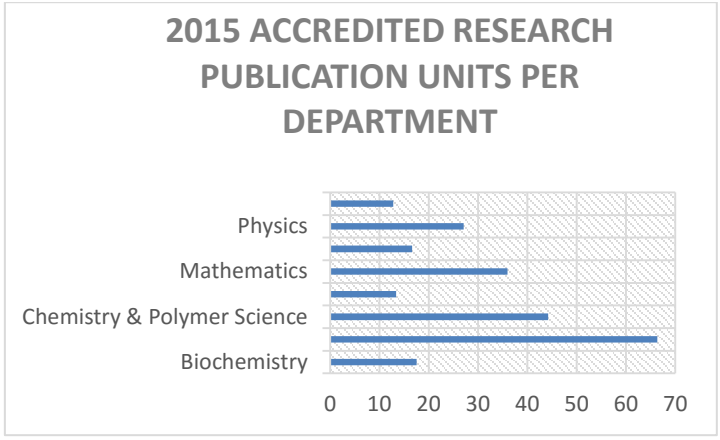
Prof. Pieter Swart, Vice-Dean: Research

The Faculty of Science prides itself on being both a centre of excellence for undergraduate and postgraduate training in the physical, biological and mathematical sciences, as well as one of research excellence.

RESEARCH PROFILE

Over the past five years the Faculty's researchers have managed to maintain a publication unit output of above 200 subsidised publication units per year.





Based on 2015 figures from Scopus and the Web of Science, the Faculty of Science has 18 researchers with an h index of 25 and higher (in order to obtain an h index of 25, one would have had to publish at least 50 papers). Prof. Dave Richardson, Director of the Centre for Invasion Biology (CIB), has an h index of 67, followed by Prof. Len Barbour from the Department of Chemistry and Polymer Science with an h index of 45 and Prof. Guy Midgley from the Department of Botany and Zoology at 43. Other researchers with above average h indexes are Prof. Bert Klumperman (40) (Chemistry and Polymer Science), Prof. JC Clemens (36) (Earth Sciences), Prof.

Leon Dicks (40) (Microbiology), Prof. Emile van Zyl (33) (Microbiology), Prof. Harald Pasch (33), Prof. Helgard Raubenheimer (31) (Chemistry and Polymer) and Prof. Brian van Wilgen (38) (CIB).

The number of NRF-rated scientists increased from 106 in 2014 to 112 in 2015. This includes 6 A-rated, 41 B-rated, 42 C-rated, 2 P-rated and 21 Y-rated scientists.

NATIONAL AND INTERNATIONAL COLLABORATION

The Faculty continuously seeks to strengthen and renew strategic alliances with entities such as the Council for Scientific and Industrial Research, iThemba LABS and first-rate international universities and institutions to build capacity and provide development opportunities for postgraduate students.

The year under review saw two new research chairs being added to the Faculty's existing nine chairs. Prof. Kathy Myburgh now holds the new SARChI chair in Integrated Skeletal Muscle Physiology, Biology and Biotechnology, while collaborative efforts with the CSIR resulted in the implementation of a joint research chair in Quantum, Optical and Atomic Physics held by Prof. Hermann Uys. In July 2015 a SU/CSIR research seminar focused on those areas where both institutions hold expertise and which hold potential for future collaboration. Smaller seminars focusing on specific areas of expertise will follow.

During 2015 our researchers, postgraduate students and postdoctoral fellows collaborated with nearly 400 institutions from 64 countries worldwide. The interactions included the co-authoring of journal articles and other publications, student and staff exchanges and research visits, as well as co-presenting workshops and seminars.

Staff and postgraduate students delivered more than a hundred (114) papers and posters at national and international conferences, including 26 plenaries and invited talks. Sixteen of our postgraduate students walked away with awards such as best talk or best poster.

Our researchers also actively contribute to the scientific community through their activities on the editorial boards of more than 75 national and international journals, either as editorial board members, editors or section editors. They also actively serve on review panels for the National Research Foundation and other international funding agencies, serve as external examiners for PhD and MSc students from local and international universities and become involved in the organisation of major local and international conferences.

Collaboration with the Katholieke University of Leuven (Belgium) and the University of London resulted in two workshops, presented in February and July 2015, to bolster the Faculty's bio-informatics programme. The workshops succeeded in equipping researchers and postgraduate students with the necessary computational resources and skills to assemble, annotate and analyse raw data.

RESEARCH GRANTS

In the course of the year several researchers managed to secure competitive grants. Prof. Carine Smith was awarded a grant from the National Research Foundation (NRF) Blue Skies programme to develop a proof-of-concept method for targeted stem-cell delivery. Prof. Mike Cherry obtained a grant from the NRF's Foundational Biodiversity Information Programme to study the effect of habitat fragmentation on faunal diversity in Eastern Cape forests. A R10 million grant from the Volkswagen Foundation was awarded to Prof. Dirk Bellstedt to develop a method to reconstruct the evolution of central Africa over the past 20 million years.

RESEARCH AND INNOVATION

The Faculty places a high premium upon creating a culture of innovation among staff and students. Five new PCT patent applications were filed during 2015:

Patents	2011	2012	2013	2014	2015
Declarations	14	4	5	9	5
Provisional patent application	9	2	3	5	2
International patent application (PCT)	5	2	2	3	5
Final Patent Application (FP)	14	5	0	0	

Prof. Marina Rautenbach, Dr Anscha Troskie, Dr Abré De Beer and Mr Arnold Vosloo registered an international patent in Europe and South Africa (pending in China, India and USA) on antimicrobial peptide compositions for plants.

A patent for removing lactose from milk without altering its flavour was filed by Prof. Bert Klumpermann and Prof. Pieter Swart, based on research done by PhD student Amanda Jane Dodd.

Prof. Marina Rautenbach filed a PCT patent application for a natural green and biodegradable antibiotic that has the potential to combat plant pathogens without damage to products during export, shipping and storage

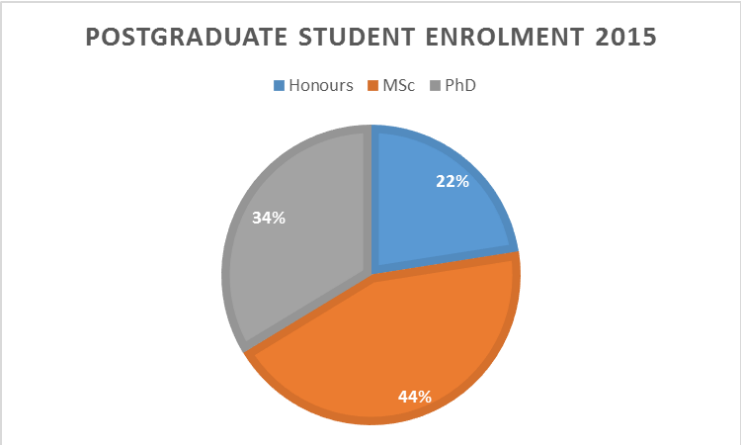
Prof. Bert Klumpermann filed a PCT patent application for a method to administer tyrocidine (a natural antibiotic compound produced by a soil bacterium *Bacillus aneurinolyticus*) to patients in a manner that does not affect the healthy cells, thereby killing the malaria parasite without being toxic to the patient.

Prof. Eugene Cloete filed a patent for a method to treat winery wastewater.

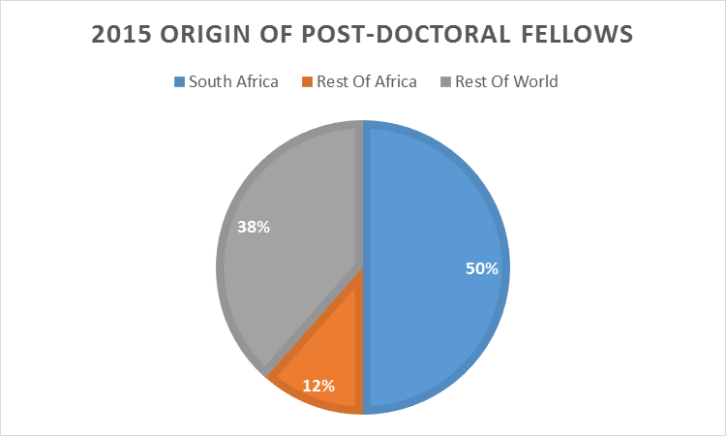
FOCUS ON POSTGRADUATE STUDENTS

For 2015, the Faculty of Science boasts with a record number of 50 PhD degrees and the most honours degrees over the past five years – 150 in comparison with the previous high of 136 in 2012.

In addition to a large cohort undergraduates, 160 honours, 311 MSc and 239 PhD full-time candidates were enrolled at the Faculty in 2015.



The Faculty of Science has done relatively well in attracting students and in particular postdoctoral fellows from other African countries and abroad, especially through the AIMS network. Since 2008 the number of postdoctoral fellows has nearly doubled from 60 to 104 in 2015.



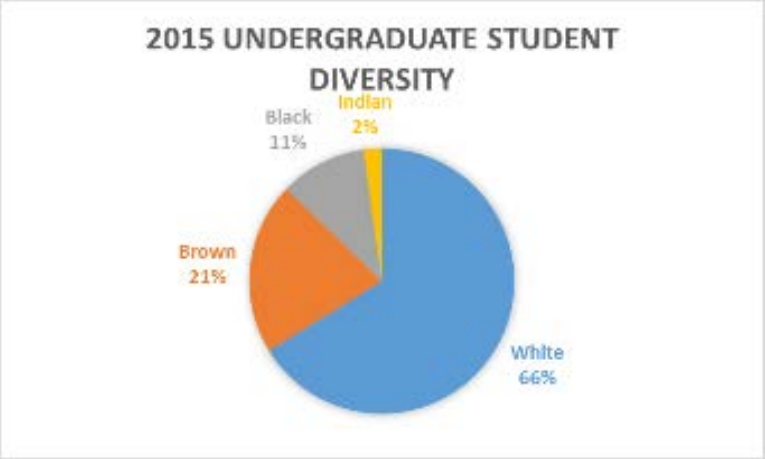
TEACHING AND LEARNING

Prof. Ingrid Rewitzky, Vice-Dean: Teaching and learning

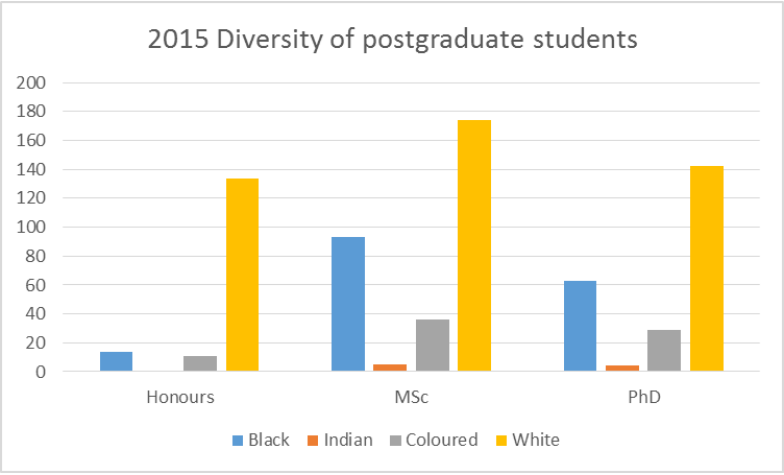
The Faculty of Science is committed to the education of young scientists in support of the South African government's initiative to create a knowledge society. Through our teaching and research, we strive to develop independent and critical thinkers who will play an active role in the development of a successful multicultural South African society.

BROADENING ACCESS

Since 2011 the number of undergraduate diversity students has gradually increased from 32% to 34% due to initiatives to recruit good students. This entailed increasing recruitment bursaries to 222 (compared with the 41 offered in 2012), resulting in 109 recruited diversity students registering in 2015 compared with 34 in 2012. In 2015 we enrolled 235 first-time entering first-year (FTE FY) BCI students.



Postgraduate diversity students have fluctuated between 36 and 41% over the last five years. There appears to be a drop in the total % of BCI postgraduate students from 2014 to 2015. However, in actual numbers this is a drop of only one BCI student combined with a larger intake of white postgraduate students. The total percentage of female students (undergraduate as well as postgraduate) has increased to 53% in 2015.



ENSURING STUDENT SUCCESS

The Faculty is committed to providing support and development opportunities for all students to reach their full potential in their chosen directions of studies. Existing and planned initiatives include:

Proficient reading, comprehension and writing skills are crucial for all science programmes. A preliminary study conducted in 2014 by the Reading Laboratory in the first semester, showed that the reading speed and reading skills of the students in the EDP are poor. An online reading programme has been implemented to improve students' (grade 1 up to first-year level) reading speed, comprehension, retention and vocabulary by means of 20 interactive lessons. Because reading skills and comprehension are essential for being academically successful, the Faculty is implementing this reading course in Scientific Communication Skills 116 and 172 from 2014 to 2016. We trust that data gathered over the three years will prove that this programme can bring about a significant improvement in the reading and especially the comprehension skills of students, thereby aiding in their academic success. The improvement in the students' reading abilities will be tested after completion of the programme, as well as six months later in conjunction with the Reading Laboratory. The results will also be compared with these students' academic performance over the same time period. Should the data confirm that the programme contributes to increased academic success, the programme will be incorporated into the curricula.

Table 1: Overall improvement in students' reading speed and comprehension after completion of the Lab-on-line reading programme

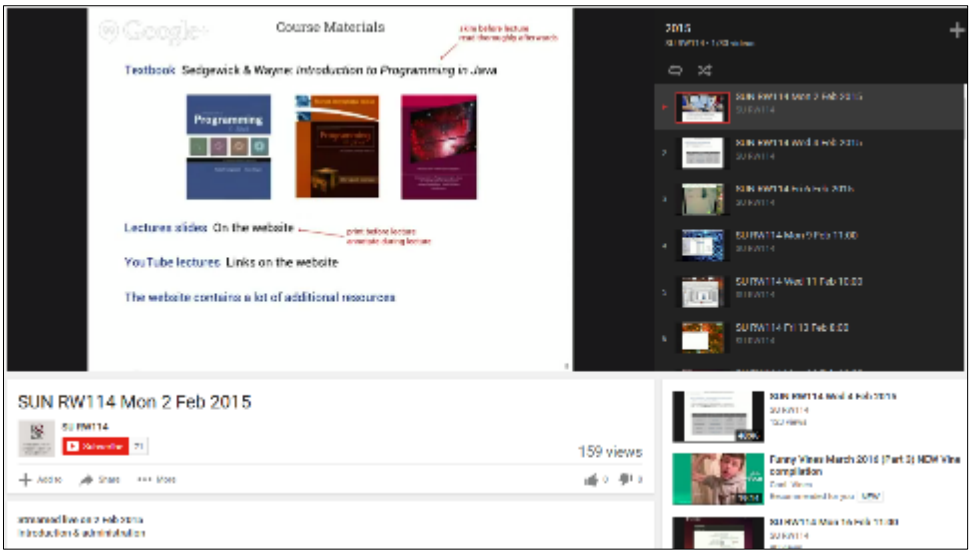
Scientific Communication Skills 116				
	Pre-test (Paper)	Pre-test (Electronic)	Post-test	Improvement
Word Per Minute	168	156	302	134
Grade level	4	3	1st year	9
Comprehension	59%	62%	83%	24%

Other ongoing initiatives include the identification and mentoring of at-risk first-year students; intensive use of ICT for learning and teaching and differential tutorial support to cater for the varying levels of preparedness of first-year students and

ICT FOR TEACHING AND LEARNING

Ms Ilse Rootman-le Grange was appointed in 2015 as the blended learning coordinator in the e-Learning Instructional Design Support Office for the Faculty of Science. The office provides professional support for lecturers using (or interested in using) ICT for enhancing teaching and learning and for e-learning systems such as Moodle, Camtasia and Turnitin.

The Centre for Learning Technologies invited Prof. Jaco Geldenhuys to present a talk on "Recording lectures without pain" during its Blended Learning Seminar on 23 July 2015. The seminar forms part of the university's drive to meaningfully integrate learning technologies into the curriculum. Prof. Geldenhuys shared details and lessons learnt with regards to a lecture capturing project in Computer Science I. All Computer Science I lectures were recorded and have been broadcast live on YouTube and archived for students and other interested parties to watch again later.



The **differentiated tutorial support programme** is catering for different levels of preparedness of our first-year students and offering different levels of support and enrichment so that each student has effective support opportunities to reach his/her level of success along the path that best suits his/her style of learning. All the departments in the faculty involved with teach first year modules appreciated the value of this intervention and have had the freedom to interpret and implement the initiative for their own context. Discussions are underway to take these initiatives to a higher level and conceptualise a strategic framework for curriculum integrated support in the faculty, with input from academics, tutors, and students.

The **Science Teaching and Learning Hub** has been invaluable for sharing of teaching and learning initiatives in the faculty and promoting a culture of inquiry through discussions, seminars and the annual Science Teaching and Learning Workshops. Through this forum academics are being inspired to present their teaching and learning initiatives in the faculty, at CTL seminars, and at the SU SoTL conference. Moreover, some individual small-scale initiatives are being adopted in other disciplines, and teaching and learning hubs have been established in all other faculties.

The **teaching assistant programme** implemented since 2013 is supporting academics in their development of teaching material, and of reliable and effective assessment tools, and in implementation of interventions for improving student engagement and for enhancing teaching and learning with ICT. Moreover, the assistants are being trained as potential future academics.

The **tutor training short course**, introduced in 2014, is equipping science students with skills to recognise different learning styles and facilitate learning in tutorials and practical sessions. Students completing the short course receive an official SU certificate in recognition of the capacities they have developed as more reflective and effective tutors who promote learning in tutorials rather than simply giving solutions from a memo.

LANGUAGE

The Faculty has actively moved towards implementing the language strategy whereby 100% of our programmes can be taken in English while keeping the percentage of a program that can be taken in Afrikaans above 60%. All first year classes are offered in parallel medium, except for a few modules with very low student numbers where the classes are offered with interpretation services. This is in

line with the university's strategic intent to broaden access, through the language offering, for all academically deserving students.

INSPIRING LECTURERS

Three lecturers from the Department of Mathematical Sciences were lauded for their inspirational lectures by six top performing first-year students during the Vice-Rector: Teaching and Learning's First-Year Prestige Dinner. Prof. Florian Breuer, from the Division: Mathematics in the Department of Mathematical Sciences, were nominated by three students, while Dr Dimbinaina Ralaivaosaona and Dr Paul Grobler, both from the Division: Applied Mathematics in the same department, were nominated by three two top-performing first year students.

Prof. Florian Breuer with Julie-Anne Gerber, Sarah Selkirk and Jacob Hugo.

Dr Marietjie Lutz and Dr Gareth Arnott from the Department of Chemistry and Polymer Science were also nominated, as well as Dr Johannes Kriel from the Department of Physics. The First-Year Prestige Dinner rewards the hard work of the 2015 first-year students and at the same time highlight the role of the lecture in the achievement of this success.

The students had the following to say about their lecturers:

About Prof. Breuer

"Your lecturing style is fantastic. Instead of just showing students how to do new work, you first tried to get us to come up with our own ideas and discover new concepts ourselves. You would always encourage discussion and involvement in your lectures. A deeper understanding of Mathematics was encouraged in lectures and you often gave us extra information, which sparked interest in the subject matter."

– Sarah Selkirk (Faculty of Science)

"'n Mens het die gevoel gekry dat u dit geniet om klas te gee en dat u graag wil hê elke student moet die vak deurkom. Meer as dit selfs: u wou hê elke student moes met 'n beter begrip van Wiskunde uitstap ná elke lesing en ek dink u het dit reggekry."

– Jacob Hugo (Faculty of Economic and Management Sciences)

"U was toegewyd om studente te help om sukses te behaal en hulle te inspireer om harder te werk. U het geluister na elke student, ons uitgedaag met probleme, laat streef na beter dinge, en ook aangemoedig om elke dag tot die beste van ons vermoë te prestreer. Dankie vir u toewyding aan elke student en dat u my so geïnspireer het."

– Julie-Anne Gerber (Faculty of Economic and Management Sciences)

About Dr Ralaivaosaona

"You surpassed my wildest hope in what I wanted in a Maths teacher. You were brilliant, funny, highly intellectually stimulating, and witty. You were not loud or demanded respect, but you definitely earned it. When you walked in the class became quite. I am convinced that the other students in my class would agree, you earned our respect, and kept it until the end."

– Ruan Viljoen (Faculty of Engineering)

"I would like to thank you for a wonderful year of Engineering Mathematics. Your energy and your enthusiasm for the subject made the lectures a joy. You motivated me to excel in this module, and with some hard work, I achieved beyond what I could have hoped for."

– René Spoerer (Faculty of Engineering)

Dr Ralaivaosaona with René Spoerer and Ruan Viljoen.

About Dr Paul Grobler

"Another enjoyable part of the lectures was the friendly informality you portrayed which made the subject much more relatable. Many other lecturers did not come close to the level of enthusiasm that was present in your lectures either – it was always inspiring to see how exciting the work was made to appear."

– Lodevicus van Niekerk (Faculty of Science)

About Dr Johannes Kriel

"What I found most enjoyable about your teaching was the absolute lack of any noticeable favouritism towards the students. You were willing to put effort into helping all students as long as they provided you with answerable questions or at least showed that they wanted to learn about this strange beast called Physics."

– Matthew Greenwood (Faculty of Science)

About Dr Marietjie Lutz

"Doktor se sin vir humor het dit ook makliker gemaak om vroeg op 'n Donderdagoggend agtuur klas by te woon. Dit, tesame met dokter se produktiewe lesings, was 'n groot motiveerder. Laastens het jy ons aangemoedig om nooit op te gee nie en om ingestel te wees om altyd iets te probeer leer."

– Nina Truter (Faculty of Science)

About Dr Gareth Arnott

"Your passion for what you do is so inspiring and motivating and there is never a dull moment in your classes. You are a marvelous lecturer, although the term 'teacher' is more accurate. I have never been intimidated to ask a question due to your approachable and friendly nature and your ability to sympathize with your students is remarkable."

– Emma van der Merwe (Faculty of AgriSciences)

Reflecting on the various teaching and learning initiatives in the Faculty of Science over the past year, several colleagues have been engaging in a scholarly approach to teaching and learning and have shown enthusiasm for engaging more in Scholarship of Teaching and Learning (SoTL) through participation in the annual SoTL conference of SU. The impact and quality of our contributions and educational practice could be improved through a more evidence-based and research-based approach to our initiatives.

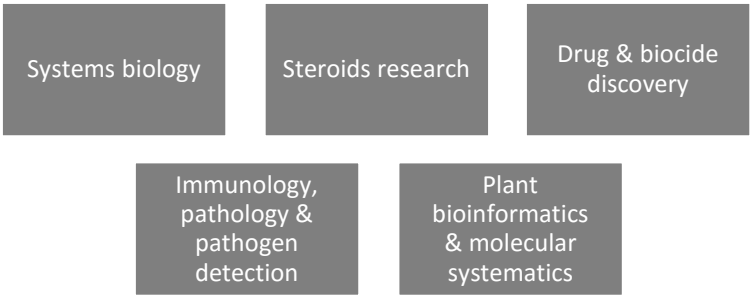
At the 8th Annual Conference on the Scholarship of Teaching and Learning (SoTL) in 27-28 October 2015, the Faculty of Science presentations included:

- Prof. Johan Rohwer and Prof. Erick Strauss: Towards blended learning in Biochemistry 364
- Prof. Kristian Müller-Nedebock: A pilot project to enhance Physics understanding through advanced algebraic and graphical software
- Dr Sonia Fidder-Woudberg: An approach to uplift spirits and enhance productivity during a Friday afternoon tutorial
- Dr Marnel Mouton, Dr Edward Archer and Dr Ilse Rootman-Le Grange: Tablet teaching in an Extended Degree Programme Biology module at Stellenbosch University.

DEPARTMENT OF BIOCHEMISTRY

Our research is positioned at the intersection of chemistry and biology, moving from molecular structures via macro-molecular activity to biological function. Research topics range from applied studies in waste water treatment, potato virus spread, contraceptives, drug discovery and malaria to fundamental work in systems biology and P450 function.

RESEARCH INTERESTS



RESEARCH HIGHLIGHTS

Mathematical model of glucose metabolism in the malaria parasite

Prof. Jackie Snoep (SARChI chair in mechanistic modelling of health and epidemiology) and Dr Dawie van Niekerk

Great progress was made in our malaria research project. Using a bottom up approach to model glucose metabolism in the malaria parasite *Plasmodium falciparum*, we constructed a mathematical model that was published in the *Federation of European Biochemical Societies Journal* (FEBSJ) 282 (2015) 1481–1511. A subsequent validation of the model pinpointing potential drug targets was accepted for publication in the same journal (doi:10.1111/febs.13615). This model was extended to include the red blood cell (the host cell in which the blood stage form of the parasite resides) metabolism and was used to simulate blood glucose metabolism in malaria patients. A concept paper on this approach was presented as oral presentation at the Metabolic Pathways conference in Braga, Portugal in June 2015 and published in *Biochemical Society Transactions* (43, 1157–1163).

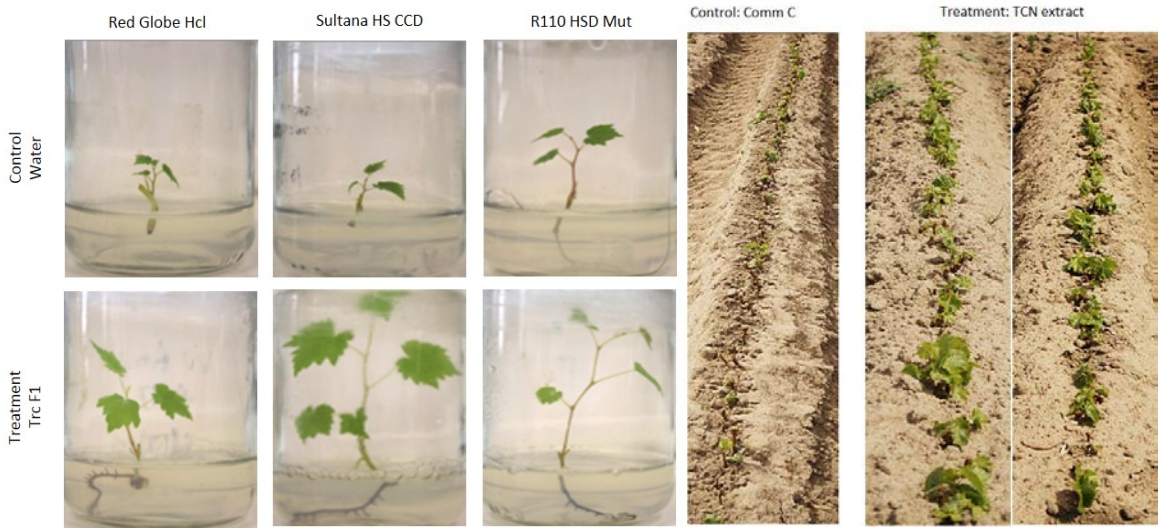
Biocide and drug discovery

Prof. Erick Strauss and Dr Marianne de Villiers were invited to write a "News and Views" article in the journal *Nature Chemical Biology* (one of the high impact journals in the field) to highlight the findings of a research article on coenzyme A biology.

International patent on antimicrobial peptide for plants registered

Prof. Marina Rautenbach (BIOPEP research group)

An international patent was registered in Europe and South Africa (pending in China, India and the USA) on antimicrobial peptide compositions for plants. This innovation, developed by Dr Anscha Troskie, Dr Abré De Beer and Dr Arnold Vosloo, has applications in green agriculture. The natural antimicrobial peptides in the patent can be used as eco-friendly antifungal compounds and as plant growth stimulators.



Reconstructing the evolution of south central Africa

The German Volkswagen Stiftung awarded a major three year grant to the value of €640 000 in the "out of the ordinary" category to a multidisciplinary team headed by Dr Ulrich Schliewen of the Department of Ichthyology in the Bavarian Natural History Collections, Germany, and Prof. Dirk Bellstedt (SU). Other members of the team are Dr FPD Cotterill, Department of Earth Sciences (SU) and Dr Samuel Niedermann, Geo-Forschungszentrum, Helmholtz-Zentrum Potsdam, Germany. The project is entitled "Linking the genomic record of living biota to reconstruct landscape and organismic evolution of south central Africa" and the study area runs from the north of Zambia to south-eastern Congo. Collaborators include zoologists from the University of Lubumbashi, Congo, and the Royal Museum for Central Africa in Tervuren, Belgium.

New equipment

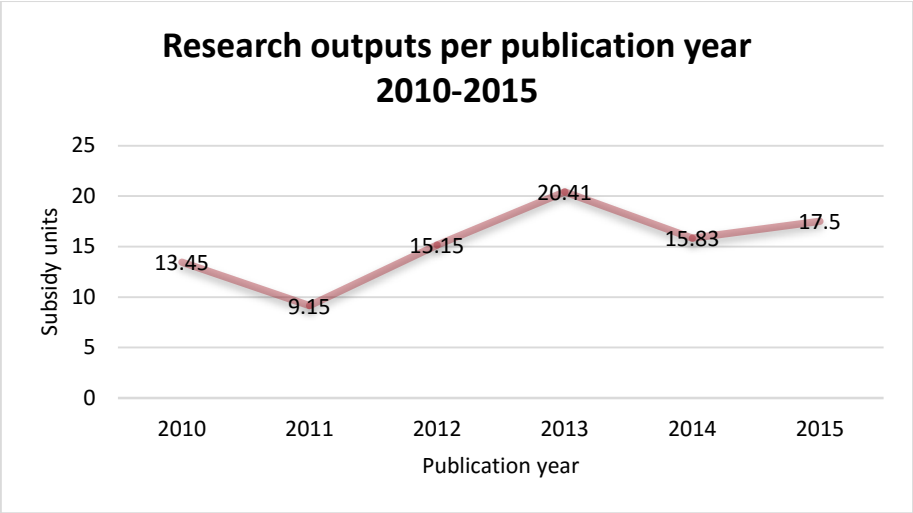
Prof. Pieter Swart, Dr Storbeck and Dr Stander were successful in obtaining funding from the NRF's National Equipment Plan for the purchase of a state-of-art ultra-performance convergence chromatography tandem mass spectrometry system housed at SU's Central Analytical Facility (CAF)

RESEARCH PROFILE

Research output

Three papers, co-authored by Prof. Snoep, have attained numerous citations: "Minimum Information About a Simulation Experiment (MIASE)" published in PLOS Computational Biology (2011; 60 citations) 7:10.1371/journal.pcbi.1001122; "Reproducible computational biology experiments with SED-ML – The Simulation Experiment Description Markup Language", published in BMC Systems Biology (2011, 84 citations) 5:198; and "BioModels Database: An enhanced, curated and annotated resource for published quantitative kinetic models", published in BMC Systems Biology (2010; 370 citations). In addition, he co-authored a publication in Molecular System Biology (five-year impact factor 12) entitled "The evolution of standards and data management practices in systems biology" (11:851).

A paper written by Dr Donita Africander and Dr Nicky Verhoog, in collaboration with Prof. Janet Hapgood from the University of Cape Town (UCT) (formerly from SU), has already been cited 90 times (Google Scholar) and currently stands at a citation index of 65 on the Web of Science. The paper, entitled "Molecular mechanisms of steroid receptor-mediated actions by synthetic progestins used in HRT and contraception" was published in *Steroids* (2011). Dr Africander and a postdoctoral fellow, Dr Renate Louw-du Toit, also in collaboration with Prof. Hapgood, published a manuscript on "Medroxyprogesterone acetate differentially regulates IL-12 and IL-10 gene expression in a human ectocervical epithelial cell line in a GR-dependent manner" in the *Journal of Biological Chemistry* (impact factor: 4.7).



NRF-rated researchers

Leading international researcher	Prof. Jannie Hofmeyr	systems biology and complexity studies
Internationally acclaimed researcher	Prof. Johann Rohwer	systems biology
	Prof. Jacky Snoep	systems biology
	Prof. Erick Strausss	mechanistic enzymology and inhibitor development
	Prof. Pieter Swart	adrenal steroidogenesis, affinity separation and protein immobilisation
Established researcher	Prof. Dirk Bellstedt	molecular systematics and immunology
	Prof. Ann Louw	steroid receptors, bioactivity of honeybush
	Prof. Amanda Swart	bioactivity of rooibos and *Sutherlandia frutescens*
Promising young researcher	Dr Karl Storbeck	steroid hormones and castration resistant prostate cancer

Research interests

Dr Donita Africander
Gene regulation; steroid receptors; progestins; bioidentical hormones; immune function and breast cancer

Prof. Dirk Bellstedt
Investigations into the evolution of viruses and bacterial pathogens of potatoes and fruit trees and their detection; plant molecular systematic and evolutionary studies of plant groups that occur in southern Africa focusing on the Cape Floral Region; development of DNA vaccines against ostrich mycoplasmas and fish phylogenetics

Dr Annelise Botes
Ostrich pathogens and vaccine development

Prof. Jannie Hofmeyr
Regulatory design of cellular processes using control analysis and computational analysis of kinetic models; enzyme kinetics for systems biology; living cell theory and code biology

Prof. Ann Louw
Steroid receptor signal transduction; steroid-binding globulins; phytoestrogens; dissociated glucocorticoids; interplay of stress and immune function

Prof. Marina Rautenbach
Antimicrobial peptides and peptide chemistry

Prof. Johann Rohwer
Enzyme kinetics for systems biology with NMR pectroscopy; kinetic modelling of energy and redox metabolism in microorganisms and plants; development of computational tools for model analysis

Prof. Jacky Snoep
Mechanistic modelling of pathophysiology of important South African diseases, including glucose metabolism in malaria patients, cholesterol and CoA metabolism of Mycobacterium tuberculosis, immune response during HIV infection, insulin signalling and glucose metabolism in muscle cells with a focus on insulin resistance and Type II diabetes

Dr Karl Storbeck
The role of adrenal steroids in castration resistant prostate cancer

Prof. Erick Strauss
Chemical biology; mechanistic enzymology; antimicrobial drug design and discovery and biocatalysis

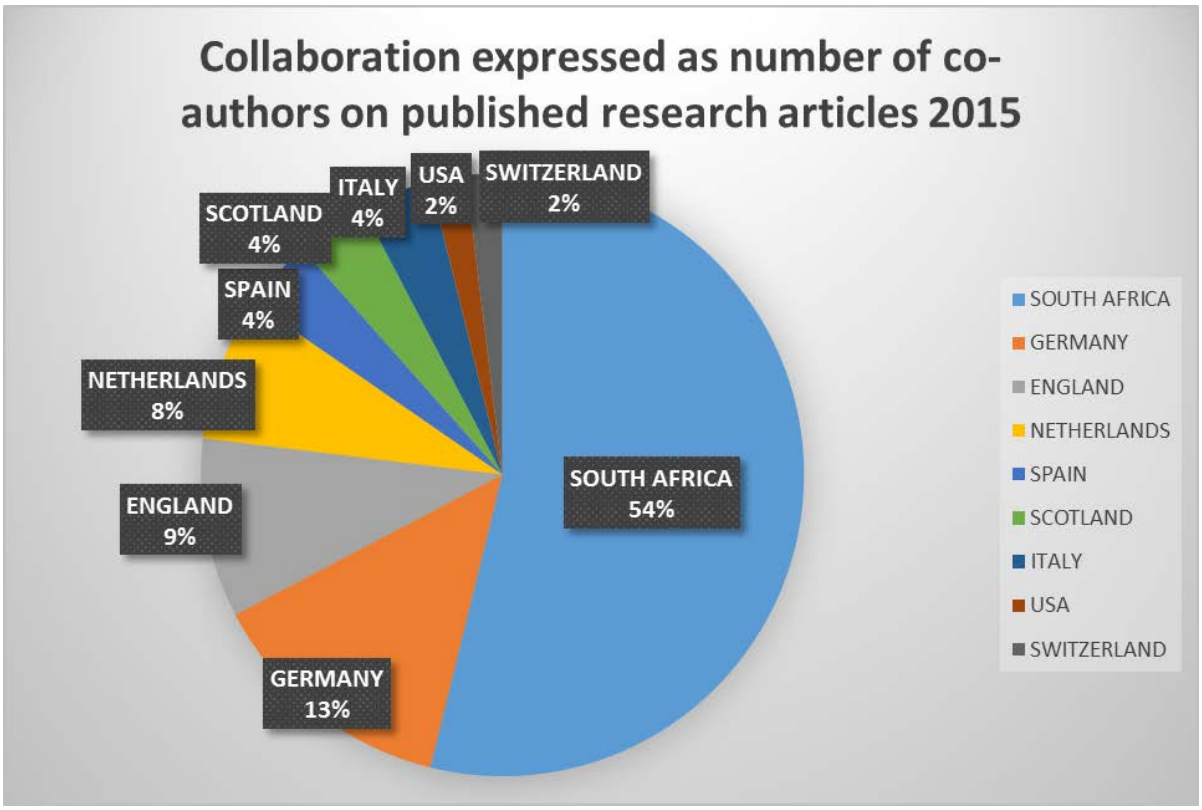
Prof. Amanda Swart
Adrenal steroidogenesis; cytochrome P450 enzymes; adrenal steroids in prostate cancer; natural plant products such as *Aspalatus linearis* (Rooibos), *Salsola tuberculatiformis Botch*. (Gannabos) and *Sutherlandia frutescens* (cancer bush)

Prof. Pieter Swart
Molecular and cellular steroidogenesis; membrane applications for the monitoring and improvement of water quality

Dr Dawie van Niekerk
Mathematical and computational systems biology; dynamical systems and pharmacometrics

Collaboration

During 2015 our researchers collaborated with authors from 36 institutions in nine different countries and published in high-impact journals such as *Taxon*, *PlosOne*, *Molecular and Cellular Endocrinology*, *Journal of Steroid Biochemistry and Molecular Biology* and *BCM Systems Biology*. Most of these articles were done in collaboration with researchers from Germany (13%), England (9%) and the Netherlands (8%).



Other collaborations include:

- Dr Africander holds a collaborative postgraduate research grant (NRF) with Prof. Janet Hapgood from the University of Cape Town. She was also a visiting scientist at the Centre for Biomedical Research, Rockefeller University, New York, USA.
- Prof. Louw has an ongoing collaboration with Prof. Günter Vollmer, Professur für Molekulare Zellphysiologie und Endokrinologie, Fachrichtung Biologie, Technische Universität Dresden, Germany.
- Dr Nicky Verhoog was the recipient of an INSIPRE scholarship and spent six months with Prof. Holger Reichardt from the University of Göttingen, Germany.
- Prof. Rautenbach initiated a collaborative research project on the structural analyses of antimicrobial peptides in materials and membranes with the group of Prof. Burkhard Bechinger, University of Strasbourg, and continued her collaborative research on the membrane interaction of antimicrobial peptides with Dr Margitta Dathe at Leipzig Institute of Molecular Pharmacology, Berlin, Germany. Prof. Rautenbach and her students Arnold Vosloo, Wilma van Rensburg and Wikus Laubscher joined the group of Prof. Burkhard Bechinger at University of Strasbourg for two research visits during 2015. In turn two group members from Strasbourg, Dr Elise Glattard and Dr Christopher Aisenbrey, came for research visits to Stellenbosch and worked with members of the BIOPEP group on a collaborative project. Prof. Rautenbach also visited Dr Margitta Dathe at the Leipzig Institute of Molecular Pharmacology, Berlin, Germany, during August 2015.
- Prof. Rohwer has a long-standing collaboration with Dr Che Pillay, School of Life Sciences, UKZN in Pietermaritzburg, on the modelling of cellular redoxin networks. He visited Dr Pillay's lab for a week in August to work on joint projects and help with the supervision of joint postgraduate students. He also visited Prof. Jonathan Gershenzon and Dr Lawrie Wright at the Max Planck Institute for Chemical Ecology, Jena, Germany and Dr Stefan Jennewein, Fraunhofer Institute for Molecular Biology and Applied Ecology (IME), Aachen, Germany, during September in the context of a collaborative project on the metabolic control analysis and modelling of the pathway of isoprenoid synthesis in bacteria and plants.
- Prof. Snoep is involved in a major international collaboration, FAIRDOM project, a joint action to establish a Europe-wide model for sustainable data and model management services in the life sciences. Four funding agencies from Germany (BMBF), the United Kingdom (BBSRC), Switzerland (SystemsX) and the Netherlands (NOW) are involved. The aim of the project is to enable system biology projects to make their data, operating procedures and models Findable, Accessible, Interoperable and Reusable (FAIR).
- Dr Storbeck spent his sabbatical (June to December 2015) as a visiting scientist in the group of Prof. Wiebke Arlt at the Institute of Metabolism and Systems Research (IMSR), University of Birmingham, United Kingdom.
- Prof. Strauss's exchange visit to the group of Prof. Ody Sibon at the University of Groningen initiated a collaboration on the study of the impact of known CoA biosynthesis inhibitors on the CoA biosynthetic enzymes of the fruit fly, *Drosophila melanogaster*. Prof. Sibon is an expert on *Drosophila* genetics, and in combination with the Strauss lab's expertise in inhibitor development allows for dual chemical/genetic knockout experiments to be run to establish mode of action. This work has implications for our understanding of certain human neurodegenerative diseases, as *Drosophila* is an often used model organism for the study of these diseases. This exchange visit, aimed at improving ties between the two research groups and their respective universities, was funded by the European Union's Saturn project, an Erasmus Mundus Action 2 project.

Funding

South Africa

Claude Leon Foundation
National Research Foundation
National Research Foundation: South African Biodiversity Initiative
NRF PhD Innovation Scholarship
NRF SARChI Initiative
Ostrich Business Chamber
Sasol
South African Malaria Initiative
South African Medical Research Council
Stellenbosch University
Working For Water Programme

International

European Union's Saturn project, Erasmus Mundus Action 2
Faculty of Agriculture, Bonn University
FPI Fellowship Mineco Spain
Generalitat de Catalunya
Hans Sigrist Foundation
Harry Crossley Foundation
International Foundation of Science Sweden
International Postgraduate Research Scholarship from the Australian Government
Japan Society for the Promotion of Science
Landgard Foundation
Leverhulme Trust
Ministerio de Economia Y Competitividad Mineco Spain
Ministerium fur Klimaschutz Umwelt Landwirtschaft Natur und Verbraucherschutz des Landes Nordrhein Westfalen
Northwestern Memorial Foundation
Nu Spore in Prostate Cancer
Nucats Dixon Translational Research Grants Innovation Award
Robert H Lurie Comprehensive Cancer Center Wendy Will Case Research Gift
Rural and Environment Science and Analytical Services Division in the Scottish Government
Russian Foundation for Basic Research
Sibbald Trust, Royal Botanic Garden Edinburgh
Swiss Academy of Sciences
Swiss National Science Foundation
Technology and Human Resources for Industry Programme Thrip
Union for International Cancer Control
Velux Stiftung
VW Foundation, Germany
Wilhelm Frank Foundation
Winetech
Yamagiwa Yoshida Memorial International Cancer Study Grant

Awards

Dr Donita Africander was awarded the HB and MJ Thom study leave bursary for her sabbatical at the Centre for Biomedical Research, Rockefeller University, New York, USA. Meghan Perkins (her PhD student) was awarded the FEBS youth travel grant to attend the FEBS advanced lecture course on nuclear receptor signalling in physiology and disease held on Spetses Island, Greece.

The BIOPEP peptide group under the leadership of Prof. Marina Rautenbach was nominated for the 2014/15 NSTF–BHP Billiton Award in recognition of excellence in Science, Engineering, Technology and Innovation as one of nine nominees in the Category: Research leading to an innovation by teams or individuals in organisations. Prof. Rautenbach was also nominated for the NSTF–BHP Billiton TW Kambule Award for research and its outputs over the last five to ten years by an individual.

Dr Storbeck received the Newton International Exchanges Award and the HB and MJ Thom sabbatical grant. Prof. Pieter Swart has been selected as a member of the *Suid-Afrikaanse Akademie vir Wetenskap en Kuns*.

Academic activities

Prof. Ann Louw

- Invited speaker on the "Potential of *Cyclopia* extracts for chemoprevention and/or chemotherapeutic use in breast cancer" at the CANSA Research in Action Conference, Stellenbosch Institute for Advanced Studies (STIAS)
- Guest speaker at the International Alumni Week 2015: Efficacy and Safety of Medical Plants and Dietary Supplements, Technische Universität Dresden, Germany. Title of the lecture was "Potential of *Cyclopia* extracts for chemo-prevention and/or chemotherapeutic use in breast cancer"
- Collaborated with Mr M. Mortimer (MSc candidate), Dr K. Visser (postdoctoral fellow), Dr D. de Beer (Post-Harvest & Wine Technology Division, ARC Infruitec-Nietvoorbij) and Prof. E. Joubert (Food Science) on an oral contribution "Divide and conquer may not be the optimal approach to retain the desirable estrogenic attributes of the *Cyclopia* nutraceutical extract, SM6Met", presented at the second International Conference on Natural Products Utilization: From Plants to Pharmacy Shelf, Plovdiv, Bulgaria
- Collaborated with Dr S. Robertson, Mr C. Barry (MSc candidate) and Prof. Johann Rohwer on an oral contribution entitled "The Importance of being dimerized: A seemingly trivial question with serious implications" for the European Molecular Biology (EMBO) Conference on Nuclear Receptors in Ajaccio, France

Prof. Marina Rautenbach

- Presented three posters and a short lecture on antimicrobial peptide research at the well-known Gordon Research Conference on Antimicrobial Peptides in Barga, Italy in May 2015, with PhD student Mr Arnold Vosloo.
- MSc student Ms Van Rensburg presented her research at the Annual UNESCO/IUPAC Conference on Macromolecules and Materials in Port Elizabeth, South Africa in September 2015
- Guest lecture on the biophysical aspects of antimicrobial peptide research at the Leibniz Institute for Molecular Pharmacology in Berlin in August 2015, as well as in November 2015 at the Swammerdam Institute for Life Sciences, University of Amsterdam
- Plenary lecture on the possible medical applications of toxic antimicrobial peptides in July 2015 at the fifth International Meeting on Antimicrobial Peptides (IMAP 2015) held at the Royal Society of Chemistry in London
- Keynote lecture of research pertaining to the membrane activity of antimicrobial peptides at the GERLI 2015 (Groupe d'Etude et de Recherche en Lipidomique) International Lipidomics Meeting of the French Lipidomics Society, held in Alsace, France

Prof. Johann Rohwer

- Invited speaker at the seventh Beilstein ESCEC Symposium "From Enzymology to Systems Biology and Back" in Ruedesheim, Germany
- Lectures on the modelling of cellular redox networks in a systems biology context, presenting work from a long-standing collaboration with Dr Che Pillay from the University of KwaZulu-Natal.
- Lectures at the eighth Scholarship of Teaching and Learning (SoTL) Conference of SU on the use of interactive response technology, i.e. "clickers", to facilitate learning in the classroom
- Lectures at the University of the Western Cape and Missouri University Plant Science Symposium on systems biology modelling work of sugarcane metabolism

Prof. Jacky Snoep

- Oral presentation on "Analysing the contribution of *Plasmodium falciparum* to whole body glucose metabolism in malaria" at the Metabolic Pathway Analysis Conference, June 2015, Braga, Portugal
- Oral presentation on "Making modelling standards more attractive to the community" at the Combine conference, October 2015, Salt Lake City, Utah, USA
- Invited speaker to the Workshop on Reproducible and Citable Data and Models, September 2015, Rostock, Germany. Title of the talk is "Reproducible model construction, validation and simulation"

Dr Karl Storbeck

- Invited speaker at the ChromSA seminar on "The analysis of androgen metabolism in prostate cancer by supercritical fluid Chromatography-tandem mass spectrometry" hosted at Stellenbosch University, 21 May 2015
- Guest lecture at the Institute of Metabolism and Systems Research (IMSR), University of Birmingham, United Kingdom, on "11β-hydroxyandrostenedione and castration resistant prostate cancer", 21 October 2015
- Guest lecture at the Fred Hutchinson Cancer Research Institute, Seattle, USA, 19 November 2015, on "11β-hydroxyandrostenedione is an alternate source of androgens in castration resistant prostate cancer"

Prof. Amanda Swart

- Invited oral lecture entitled "Adrenal 11β-hydroxyandrostenedione contributes novel androgenic ligands to the prostate tumor microenvironment" at ENDO-2015 March 5-8 San Diego California, USA
- Invited pleanary leacture entitled "The contribution of adrenal C19 steroids to the androgen pool – profiling androgens in prostate cancer" at the third International Congress on Steroid Research, Chicago, USA from 15 to 18 November 2015
- Invited speaker at the Department of Physiology, Adrenal Research Group, University of Michigan, Ann Arbor, Michigan. Talk entitled "From unknown steroids to active tissue androgens: the untold story". 3 November 2015
- Invited speaker at the Department of Urologic Surgery and Centre of Cancer Biology, NorthShore University HealthSystem Research Institute, Evanston, Illinois. Talk entitled "Adrenal androgens in prostate cancer: is 11β-Hydroxyandrostenedione the elephant in the room?" 23 November 2015

Prof. Pieter Swart

- Lecture entitled "Cytochrome b5: Novel activities for an old player" at BIT's sixth Annual World Gene Convention-2015 (WGC-2015) in Qingdao, China
- Served as Vice-dean: Research in the Faculty of Science
- Invited speaker at the 1st African Conference on Health Effects of Endocrine Disruptors – Challenges and Opportunities. Skukuza Conference Centre in the Kruger National Park, South Africa 2-6 November 2015, presenting a plenary lecture entitled: "The development of an aquatic endocrine disrupting compound detection system for Africa".

Dr Karl Storbeck, Dr Donita Africander and Prof. Amanda Swart

- A collaboration between Dr Karl Storbeck, Dr Donita Africander and Prof. Amanda Swart with their postgraduate students Ms E. Pretorius (MSc student), Mr J.L. Quanson and Ms M. Perkins (PhD students) resulted in a presentation on "11-ketotestosterone and 11-ketodihydrotestosterone: potent androgens implicated in the development of castration resistant prostate cancer" at the third Congress on Steroid Research, in Chicago, United States of America, from 15 to 18 November 2015

Service to the scientific community

Dr Donita Africander

- External moderator for a third year course in Molecular and Cellular Biology (MCB3025F) at UCT; Served on the council of the South African Society of Biochemistry and Molecular biology (SASBMB)

Prof. Dirk Bellstedt

- NRF review panel for Research and Technology Funding (Animal).

Prof. Ann Louw

- *Steroids* (Editorial board member); External examiner for third year and Honours Biochemistry courses at Nelson Mandela Metropole University

Prof. Marina Rautenbach

- *Journal of Microbiological Methods* (editorial board member); *Chemical Biology* (review editor); *Frontiers in Chemistry and Molecular Biosciences (*editorial board member); External examiner for the third year and Honours Biochemistry courses at Nelson Mandela Metropole University and the Honours course in Pharmacology at University of Cape Town medical school; Co-organiser of the AMP-AC21 (Antimicrobial Peptide – Academic Consortium 21) workshop and symposium on Antimicrobial Peptides and Biomaterials, Strasbourg, France

Prof. Johann Rohwer

- *BMC Systems Biology* (associate editor); *Frontiers in Plant Science* (section Plant Systems Biology) (review editor); Member of the international STRENDA (Standards for Reporting Enzymology Data) Commission; External examiner for UCT Biochemistry

Prof. Jacky Snoep

- *Federation of European* Biochemical Societies Journal (FEBSJ) (editor); IET Systems Biology and Metabolomics and Microbiology (*editor)*
- External examiner for the PhD thesis of Siu Hung Joshua Chan from the Technical University of Denmark in Copenhagen

Dr Karl Storbeck

- Served on the council of the South African Society of Biochemistry and Molecular biology (SASBMB)

Prof. Eric Strauss

- Served on the NRF Rating Assessment Panel for Biochemistry, Molecular and Cell Biology

Prof. Amanda Swart

- *Scientific Reports* (editorial board member since 2014); External moderator for final year Biochemistry Course at Pretoria University

Prof. Pieter Swart

- Member of the *Angora Goat Research Advice Committee* (2002 - present); Member of WRC steering committees; Member of the *Suid Afrikaanse Akademie vir Wetenskap en Kuns* (2015 - present)

Dr Dawie van Niekerk

- Served on the NRF Thuthuka review panel for Microbiology, Biochemistry, Biotechnology, Geography and Earth Sciences

Social impact

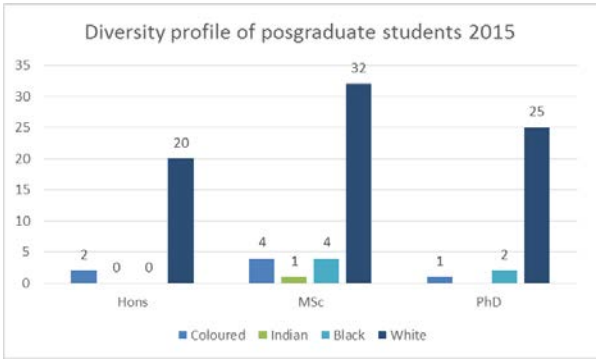
Prof. Marina Rautenbach participated in a Department of Science and Technology initiated radio interview on 14 Aug 2015. She spoke to Alina Dreben on SABC Radio X-K FM on women in science and science education. Radio X-K FM is a community radio station that broadcasts in !Xu, Khwe and Afrikaans and reaches into the rural areas of Northern Cape and Eastern Free State.

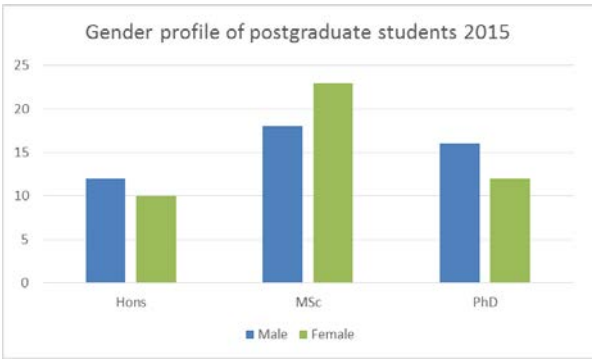
ACADEMIC AFFAIRS

Focus on postgraduate students

In 2015 the Department again had a large cohort of 91 full-time postgraduate students and 11 postdoctoral fellows. Since 2013, there has been a steady increase in postgraduate student numbers on honours, Masters and PhD-level.

During the 2015 graduation ceremony, 22 Honours, 10 MSc and five PhD students graduated successfully.





Staff matters

Prof. Amanda Swart was promoted from associate professor to professor from 1 January 2016.

Staff list

Academic staff

Dr DJ Africander
Prof. DU Bellstedt
Dr A Botes
Prof. J-HS Hofmeyr
Prof. A Louw
Prof. M Rautenbach
Prof. JM Rohwer (Head of department)
Prof. JL Snoep
Dr. K Storbeck
Prof. E Strauss
Prof. AC Swart
Prof. P Swart (Vice-Dean: Research)
Dr DD van Niekerk

Extraordinary professor

Prof. WCA Gelderbloem

Support staff

Ms WW Maart (Secretary)
Mr AP Arends
Mr KD Botha
Mr R Brandt
Mrs H Bredell
Mrs CA de Villiers
Mrs L du Toit
Dr Y Engelbrecht
Mrs AP Februarie
Mrs GD Gerstner
Mr CR Jansen
Mrs C Langeveldt
Ms RP Louw
Dr MA Stander

Postdoctoral fellows

Dr L Bloem
Dr R Domingo
Dr J Eicher
Dr L Koekemoer
Dr R Louw-du Toit
Dr T Magcwabeba
Dr AM Troskie
Dr JC Visser
Dr GA Wells

Research associates

Dr MD Pirie

New appointments

Dr M de Villiers
(RCA fellow/Researcher

DEPARTMENT OF BOTANY AND ZOOLOGY

The Department of Botany and Zoology is a leader in the field of evolutionary biology, with a specific focus on the unique opportunities offered by Africa's biodiversity.

RESEARCH INTERESTS

- Animal evolutionay ecology & physiology
- Evolutionary ecology
- Animal plant interactions
- Behavioural ecology
- Cape Flora
- Invasion biology
- Ecophysiology
- Evolutionary genomics
- Marine research
- Nutritional plant physiology
- Vertebrate functional biology & herpetology
- Global change ecology
- Medicinal plant biotechnology

RESEARCH HIGHLIGHTS

Restoring bird life and building biodiversity leadership

The lingcungcu project aims to restore broken migration routes over the Cape Flats by planting indigenous bird-pollinated plants at schools in the area. These schools will then become critical "stepping stones", helping birds to move between natural areas such as Silvermine and Rondevlei. lingcungcu is the isiXhosa word for long-billed sunbirds and sugarbirds – these birds pollinate over 350 plants in the Fynbos but are threatened by urbanisation. The project is part of Bongani Mnisi's MSc work under supervision of Prof. Anton Pauw.

Learners from Steenberg High School on the Cape Flats helping to plant indigenous fynbos to provide migratory corridors for sunbirds across the Cape Flats.

New research on population genetics of South Africa's great white sharks

Dr Sara Andreotti

The white shark population around the South African coast line has such a low level of genetic diversity that it may seriously jeopardizes their capability to survive into the future. Dr. Sara Andreotti, who collected genetic samples as part of her doctoral research at SU, relied on the expertise of well-known shark conservationist, Michael Rutzen, to track down white sharks along the South African coast line. The field work took four years to complete. Between 2011 and 2014 they collected over 302 genetic samples and 5000 photographs.

The results of the study have been published in an article 'New insights into the evolutionary history of white sharks, *Carcharodon carcharias*' in the *Journal of Biogeography*.

The genetic diversity of the South African white shark population is the lowest of all white sharks in the world. The researchers found only four maternal genetic lineages in the South African population, with 89% of all the sharks sharing the exact same gene sequence. When compared with other marine species, it is even lower than that of the highly endangered bottlenose dolphin (*Tursiops truncates*).

The DNA of the South African white sharks was also compared with the DNA of 58 white sharks analysed in previous studies conducted elsewhere in the world. The results reveal that a unique lineage exists along the South African coast line that is distantly related to other known lineage elsewhere in the world.

It appears that all white sharks originated from one common ancestral group in the Indo-Pacific Ocean around 14 million years ago. Based on the data the researchers could predict a west to east migration pattern and an ancestral link between the white sharks of South Africa and Florida. The findings have serious implication for the future management of the white shark population along the South African coastline.

Dr. Sara Andreotti (on the right) with shark conservationist Mike Rutzen taking biopsy samples from great white sharks along the South African coast line. Photos: Sara Andreotti and Gotz Froeschke ©Shark Diving Unlimited

Problem leopards should not be moved further than 100 km

Leopards that come into conflict with humans should not be translocated further than 100 kilometres from where they were caught, as it can compromise their natural spatial genetic structure and diversity.

This is one of the findings of a comprehensive analysis of the genetic structure of the southern Africa leopard (*Panthera pardus)*, conducted by a multidisciplinary team of researchers from South Africa, the United Kingdom, Australia, Norway, the United States of America and France.

The results of the study were recently published in the journal *Comptes Rendus Biologies*.

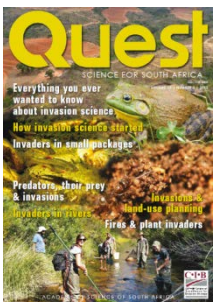
The leopards have high genetic diversity, with relatively low inbreeding, thus suggesting minimal vulnerability from small population size, inbreeding depression or mating strategies. However, this natural picture of genetic diversity can change when problem leopards are translocated to reduce conflict with humans.

The research team employed a gene dispersal index, incorporating information such as home range sizes of leopards and the sex ratio of individuals in a certain area, to determine the maximum distance a leopard can be moved in one generation before it starts intruding on the territory of another, genetically-different, group of leopards. The verdict for western Cape leopards is not further than 82 kilometres.

The research is a first step towards the development of guidelines for maintaining the natural genetic structure and diversity of the southern African leopard population.

The research team was assisted by several private individuals, as well as CapeNature, the Cape Leopard Trust, Panthera and the Niassa Carnivore Project. DNA samples were collected from 145 leopards originating from the Kruger National Park, Mkuze and Phinda Game Reserves in KwaZulu-Natal, the Baviaanskloof World Heritage Site in the Eastern Cape, the Niassa province in Mocambique and one sample from southern Zimbabwe.

Special issue of Quest on invasion science



Several of our researchers contributed to a special issue of Quest focusing on invasion science. The articles covered topics such as "Everything you ever wanted to know about invasion science", "How invasion science started", "Invaders in small packages", Invasions and land-use planning", as well as several articles on different invaders.

Bee industry needs to act quickly against outbreak of AFB disease

Recent reports indicate that close to 40% of all commercially kept bee colonies in the Western Cape are infected with the devastating American foul brood disease (AFB), with little to no information about what is happening in the rest of the country.

AFB is one of the most widespread and destructive bee brood diseases in the world. The first Cape honey bee (*Apis mellifera capensis)* colonies with clinical symptoms of AFB were confirmed in the Western Cape in 2009.

The disease is caused by the spore-forming bacterium *Bacillus larvae* which enters the digestive tract of the larva with food. The spores germinate in the midgut finally penetrating the gut wall killing the

larva which then emits a rotten smell. The bacteria sporulate in the dead larva releasing up to 2500 million spores.

Eventually the entire colony becomes weakened with other colonies becoming contaminated within the apiary through the transmission of spores, starting a new cycle of infection. It is exceptionally difficult to kill the spores. The only effective solution is to burn all the affected colonies and the equipment.

RESEARCH PROFILE

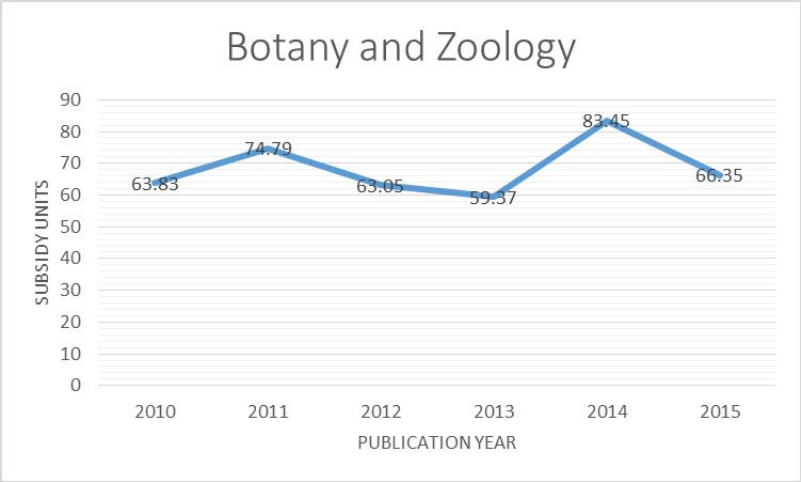
Research output

Several of the 166 accredited research articles were published in high-impact journals such as the *Proceedings of the Royal Society B*, *Evolution*, *Nature*, *Systematic Biology*, *Molecular Ecology*, *Nature Climate Change*, *Proceedings of the National Academy of Sciences*, *Biological Review*, *Trends of Ecology* and *Evolution and New Phytology*.

The article published in 2015 in *Nature Climate Change* on "Assessing species vulnerability to climate change", co-authored by Prof. Guy Midgley, has already been cited 26 times (source: Scopus data accessed on 23 May 2016).

Other highly-cited articles since 2011 include: (data retrieved on 4 March 2016)

- Meredith, R.W., Janečka, J.E., Gatesy, J., Ryder, O.A., Fisher, C.A., Teeling, E.C., Goodbla, A., Eizirik, E., Simão, T.L.L., Stadler, T., Rabosky, D.L., Honeycutt, R.L., Flynn, J.J., Ingram, C.M., Steiner, C., Williams, T.L., Robinson, T.J., Burk-Herrick, A., Westerman, M., Ayoub, N.A., Springer, M.S., Murphy, W.J. Impacts of the cretaceous terrestrial revolution and KPg extinction on mammal diversification. 2011. *Science*, 334 (6055), pp. 521-524. **Cited 408 times**.
- Blackburn, T.M., Pyšek, P., Bacher, S., Carlton, J.T., Duncan, R.P., Jarošík, V., Wilson, J.R.U., Richardson, D.M. 2011. A proposed unified framework for biological invasions. *Trends in Ecology and Evolution*, 26 (7), pp. 333-339. **Cited 270 times**.

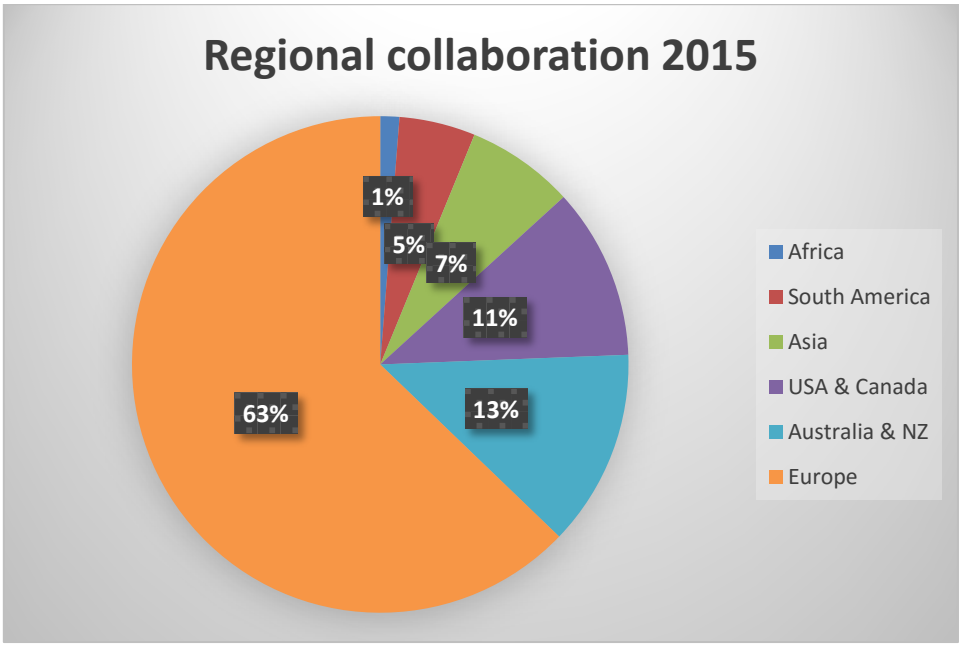


NRF-rated researchers

Leading international researcher	Prof. Dave Richardson	biological invasions and conservation biogeography
	Prof. Terry Robinson	evolutionary genetics and phylogenomics of mammals
Internationally acclaimed researcher	Prof. Conrad Matthee	molecular systematics and phylogeography
	Prof. Guy Midgley	global change biology
	Prof. Valdon Smith	Antarctic and Southern Island biology and ecology
	Prof. Michael Cherry	behaviour ecology
	Prof. Bruce Anderson	plant-animal interaction
Established researcher	Prof. Savel Daniels	molecular systematics, phylogeography and conservation of invertebrata
	Prof. Leanne Dreyer	evolution of Cape Flora
	Prof. LeFras Mouton	evolutionary ecology of lizards
	Prof. Alex Valentine	molecular physiology of host-microbe interactions of legumes in phosphorus deficient soils
Promising Young Researcher	Dr Susanne Clusella-Trullus	thermal adaptation of ectotherms and implications for climate change
	Prof. Allan Ellis	evolutionary ecology of plants and insects
	Dr Jaco Le Roux	evolutionary biology and ecology of plant invaders
	Dr Nox Makunga	medicinal plant biotechnology
	Prof. Anton Pauw	evolutionary ecology of plants and their pollinators
	Dr Carol Simon	marine invertebrate reproduction and polychaete worm taxonomy
	Dr Sophhie von der Heyden	marine molecular ecology and conservation

Collaboration

During 2015 the Department's researchers co-authored publications (including research articles, book chapters and conference proceedings) with researchers from over a hundred institutions in nearly 50 different countries worldwide. Viewed from a regional perspective, with South Africa excluded, more than two thirds of these publications were done with researchers from Europe, followed by Australia and New Zealand and the USA and Canada.



During 2015 the Department hosted a number of national and international visitors, including:

- Associate Prof. James Vonesh, Virginia Commonwealth University, gave a lecture: "Out of the frying pan and into the fire? Predicting effects of sequential predators across prey life stages" on 4 March 2015.
- Dr Larry Carbone, Senior veterinarian and associate director of the Laboratory Animal Resource Center, University of California, San Francisco, gave a talk on "Animal Ethics: a review for life scientists" on 15 April 2015.
- Prof. Neil Cumberlidge, Northern Michigan University, gave a lecture on "Freshwater crab biodiversity in the Afrotropics: the need for conservation" on 13 May 2015.
- Prof. Ben Evans, Department of Biology, McMaster University, lecture on "Evolution of sex chromosomes in frogs, especially African clawed frogs (*Xenopus*)" on 24 June 2015.
- Dr Pietro Landi, Department of Mathematical Sciences, Stellenbosch University, and Evolution and Ecology Program, International Institute for Applied Systems Analysis, Laxenburg, Austria, gave a talk on the "The mathematics of evolution" on 5 August.
- Dr Kirsten Wimberger, Wild Bird Trust, talk on "Wildlife rehabilitation in South Africa: animal welfare and conservation implications" on 12 August 2015.
- Prof. John Pannell, Department of Ecology and Evolution, University of Lausanne (Switzerland), gave a lecture on "The selection and evolution of combined versus separate sexes in plants" on 12 October 2015.
- Dr John Virtue, manager: Natural Resources Management Biosecurity, Biosecurity SA, Primary Industries and Resources South Australia, gave a talk on "Invasive species management in mediterranean and arid South Australia. A case of déjà vu?" on 23 October 2015.
- Prof. Alain Goossens, Vlaanders Institute for Biotechnology, Department of Plant Systems Biology, Ghent University, gave a talk "Engineering of plant specialized metabolism, can we break the multiple feedback loops?" on 26 October 2015.
- Prof. William Bond, from where, gave a talk "Towards a research agenda on global change in South African ecosystems" on 20 November 2015.
- Prof. Dominique Strasberg from the University of La Réunion gave a talk "Overview of Mascarenes Islands: biodiversity, conservation and research issues" on 10 September 2015.

Funding

South Africa

Andrew Mellon Foundation
Agricultural Research Council, South Africa
Claude Leon Foundation
Council for Scientific and Industrial Research
Drakenstein Trust
DST NRF Centre of Excellence for Invasion Biology
DST NRF Centre of Excellence in Tree Health Biotechnology
Ernst and Ethel Eriksen Trust
Fynbos Forum Table Mountain Fund
National Research Foundation South Africa
Nelson Mandela Metropolitan University
NERC
Oppenheimer Memorial Trust
South African National Biodiversity Institute
South African National Parks
South African Ostrich Business Chamber
South African Research Chairs Initiative fo the Department Of Science and Technology
South African Water Research Commission
Stellenbosch University
Table Mountain Fund
University of Cape Town
University of Johannesburg
University of Pretoria
Urban Wild Lands Group
Water Research Commission, South Africa
West Coast National Park
Western Cape Agricultural Research Trust
Wilderness Wildlife Safaris Trust

Working For Water Programme

International

Austrian Climate Research Program
Czech Academy of Sciences
Czech Science Foundation
DFG
German Academic Exchange Service DAAD
German VW Foundation
King Saud University Distinguished Scientist Fellowship Program
Leverhulme Trust
Ministry of Education Youth and Sports of the Czech Republic
National Geographic Young Explorers Grant
University Of Queensland St Lucia
Severo Ochoa Program for Centres of Excellence in RDI
Spanish Mineco Project Montes
Spanish Mineco Project Rixfutur
Spanish Ministry of Economy and Competitiveness
Swedish Research Council
Swiss Academy of Sciences
Swiss National Science Foundation
Synthesis Centre for Biodiversity Sciences within the German Centre for Integrative Biodiversity Research Idiv Halle Jena Leipzig
Tsinghua University
United Kingdom Natural Environment Research Council
United States Agency for International Development USAID
University of Basel
University of California Riverside
University of Cambridge
USDA National Institute of Food and Agriculture Hatch Project
Vermont Agricultural Experimental Station
World Bank through WWF CARPO
World Bank through WWF US

Awards

Prof. Dave Richardson was honoured with the Havenga Prize for Life Sciences, awarded by the *Suid-Afrikaanse Akademie vir Wetenskap en Kuns*. He also received the SU's Chancellor's Award for his continued contribution to research excellence. Prof. Mike Cherry was elected Fellow of the African Academy Of Science. Dr Jaco le Roux received the SU Vice-Rector: Research, Innovation and Postgraduate Studies' award for research excellence.

PhD student Ethan Newman.

Our postgraduate students also performed well. Ethan Newman received the Research Excellence Award for Next Generation Researchers, awarded by the National Research Foundation and handed over by the Minister of Science and Technology (DST), Mrs. Naledi Pandor, during a special ceremony on 27 August 2015. The young researchers were recognized for outstanding academic performance as final year doctoral students.

Andria Rautenbach won the award for the best talk by a young scientist during the annual conference of the South African Association for Botanists in January 2015. Two PhD students, Andrew David and Tendai Musvuugwa, won best student oral presentation awards at two international conferences. Andrew attended the International Conference of Invertebrate Reproduction and Development in Detroit (USA). His presentation was entitled "Reproduction and larval development of the obligate shell borer Polydora hoplura (Polychaeta: Spionidae) from South Africa with first report of poecilogony in the species" with co-workers Dr Carol Simon and Prof. Conrad Matthee. Tendai Musvuugwa attended the Student Conference in Conservation Science, Theme: Biodiversity in Africa – Present state, Challenges and Prospects on its

Conservation which was held in Nairobi, Kenya. Her presentation was entitled "Biodiversity and ecology of ophiostomatoid fungi associated with native trees in the Cape Floristic Region of South Africa" with supervisors Dr Leanne Dreyer, Dr Francois Roets and Dr Jaco le Roux.

Chris Broeckhoven receiving one of his prizes at the New Voices in Science competition hosted by SU.

Several of our students were finalists in SU's New Voices in Science competition where they also walked away with some of the top awards: Chris Broeckhoven received the award for the Best 60 second video clip and the Best Popular Science Talk; Caroli de Waal won the category Best Popular Science Article; and Christina Glyn-Woods was the runner-up in the best popular science article category. Lisa Martins was a runner-up in the Postgraduate and International Office's postgraduate video competition. Susan Canavan won the best MSc presentation at the annual research meeting of both the Centre for Invasion Biology (CIB) and the Annual Research Meeting of the Department of Botany and Zoology. Dr Natasha Mothapo was awarded the Carolina MacGillavry Collaborative Research Award from the International Foundation of Science: Africa Collaborative Research.

Academic activities

The departmental evaluation took place from 12 to 15 October 2015 and was conducted by Prof. Paulette Bloomer, head of the Department of Genetics at the University of Pretoria, Prof. William Bond from the Department of Biological Sciences at the Univeristy of Cape Town, and Prof. John Pannell from the Department of Ecology and Evolution at Lausanne University (Switzerland). Other activities include:

Prof. Michael Cherry

- Talk to senior students at the Michael Oak Waldorf School, Cape Town

Prof. Leanne Dreyer

- Invited speaker at the International Dimensions Conference, hosted by the South African National Biodiversity Institute (SANBI) in March 2015

Prof. Nox Makunga

- Preconference Talk at the Society for Economic Botany and presentations together with !Qora Damonse of the Cape Bush Doctors' Association

Dr Jaco le Roux

- Co-host of international workshop on "The evolutionary dynamics of tree invasions", Stellenbosch, November 2015
- Co-leader of working group on "The socio-ecology of Acacia invasions" (co-funded by SESYNC and sDiv) and attended five meetings in Annapolis, Maryland (USA) and Leipzig (Germany) from 2014 to 2015

Prof. Theresa Wossler

- Attended the annual conference of the Entomological Society of South Africa, Grahamstown

Prof. Conrad Matthee

- Attended the Evolution meeting in Guaruja, Brazil

Service to the scientific community

Prof. Bruce Anderson
- External moderator for three courses at the University of Cape Town

Prof. Michael Cherry
- *Emu* (associate editor); *Folia Zooligia* (editorial board member); Kalahari Research Trust (trustee); Fitzpatrick Centre of Excellence (board member)

Dr Susanne Clusella-Trullas
- Journal of Thermal Biology (editorial board); Austral Ecology (editorial board); Frontiers in Insect Physiology (editorial board); Functional Ecology (associate editor); Special issue on insects invasions, Biological Invasions Journal (editor); Member of the scientific committee for the World Congress of Herpetology (2016

Prof. Leanne Dreyer
- Woordeboek van die Afrikaanse Taal (consultant); DST/NRF Centre of Excellence in Tree Health Biotechnology (core member); external examiner honours programme, University of KwaZulu-Natal

Prof. Allan Ellis
- *Biological Journal of the Linnean Society* (associate editor); hon secretary of the South African Association of Botanists (SAAB); reviewer for proposal from the National Research Foundations of New Zealand and Israel

Dr Jaco le Roux
- *Biological Invasions* (associate editor); *Conservation Genetics* (associate editor); Member of the SANBI Genetic Monitoring working group

Prof. Nox Makunga
- National Research Foundation panel for competitive rated and unrated researchers (member); *Frontiers in Plant Biotechnology* (assistant editor); external examiner for UCT, UKZN and UFS

Prof. Conrad Matthee
- Molecular Phylogenetics and Evolution (associate editor); Koedoe (editorial board); African Journal of Marine Science (editorial board)

Prof. Guy Midgley
- NRF rating panel member; chair of the NRF/DST global change committee

Prof. Lafras Mouton
- Rooi Cederberg Karoo Park (advisory board member); Radio Sonder Grense "Hoe verklaar u dit?" (team member); Herpetological Association of Africa (chair); *African Journal of Herpetology* (editorial board)

Prof. Anton Pauw
- *South African Journal of Botany* (sub-editor); Darling Wildflower Conservation Trust (committee member); external examiner third year genetics module, UJ; National Research Foundation panel for competitive rated and unrated researchers (member); external examiner University of the Witswatersrand (WITS) – Honours Programme and third year modules

Dr Victor Rambau
- Zoological Society of Southern Africa (committee member); *African Zoology* (section editor)

Prof. Dave Richardson
- *Diversity and Distributions* (editor in chief); Neobiota Biological Invasion (associate editor); *Forest Ecosystems AOB Plants* (editorial board member); IUCN: Invasive Species Specialist Group (member)

Prof. Terry Robinson
- *Cytogenetic and Genome Research* (editorial board member); *Chromosome Research* (editorial board member)

Dr Tammy Robinson
- NRF Research and Technology Funding: Fisheries and Aquaculture (panel member); World Registry of Invasive Marine Species (thematic editor)

Dr Carol Simon

- *African Zoology* (co-editor in chief); National Research Foundation panel for competitive rated and unrated researchers (member); ZSSA (executive council member); NRF-IBIP review panel member

Prof. Alex Valentine

- JS Marais Park's management committee (advisory board member); *Fungal Ecology* (guest editor); *South African Journal of Plant and Soil* (associate editor); External Examiner for UKZN; NRF SARCHI chairs panel

Prof. Hannes van Wyk

- EDCAfrica conference organising committee member; Junior Captain Scott Panel member;

Dr Sophie von der Heyden

- South African Network for Coastal and Oceanographic Research (SANCOR) (elected as chair in 2015 and postdoctoral fellowship committee member); SANBI Genetic Monitoring Committee member

Prof. Theresa Wossler

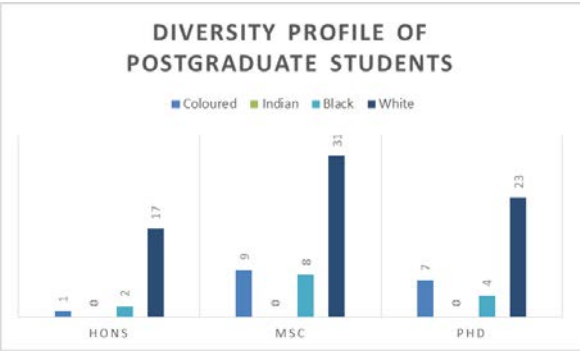
- *African Zoology* (editor); *African Entomology* (assistant editor); Helderberg Nature Reserve Protected Area Advisory Committee member; external examiner honours UWC

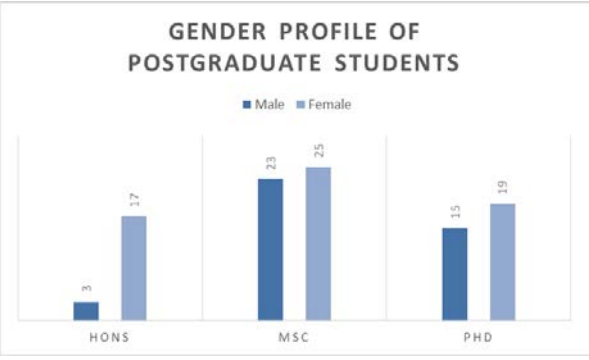
Social impact

Through Prof. Alexander Valentine, the Department is involved with an outreach project at Floreat Primary School at Steenberg on the Cape Flats. So far the Department has contributed to the school's advanced biology laboratory, practicals and learning material. The next project will be to collect books for the school's library.

ACADEMIC AFFAIRS

Focus on postgraduate students





Staff matters

Dr. Jaco le Roux, Dr Susana Clusella-Trullas and Dr Sophie von der Heyden were promoted from senior lecturer to associate professor as from 1 January 2016, while Dr Nox Makunga was promoted from senior lecturer to associate professor from 1 January 2015. Dr Tammy Robinson was promoted from lecturer to senior lecturer as from 1 January 2015.

Staff list

Academic staff

Prof. Conrad Matthee (Executive head)
Prof. BC Anderson
Prof. MI Cherry
Dr S Clusella-Trullas
Prof. SR Daniels
Prof. LL Dreyer
Prof. AG Ellis
Dr AF Flemming
Dr JJ Le Roux
Prof. NP Makunga
Prof. G Midgley
Prof. PLN Mouton
Dr M Mouton
Prof. A Pauw
Dr RV Rambau
Prof. DM Richardson (Distinguished professor)
Prof. TJ Robinson
Dr TB Robinson
Dr CA Simon
Prof. AJ Valentine
Prof. JH Van Wyk
Dr S Von der Heyden
Prof. T Wossler

Centre of Excellence for Invasion Biology

Prof. DM Richardson (director)
Dr John Measey
Prof. Brian van Wilgen

Extraordinary professors

Prof. SL Chown
Prof. BW van Wilgen

Extraordinary associate professors

Prof. KJ Tolley
Prof. JR Wilson

Support staff

Ms S Jacobs (principal secretary)
Ms J Basson
Mr A Fransman
Ms F Gordon
Ms RM Honing
Ms S Johnson
Ms DJD Julies
Dr A Kleinert
Ms J Law-Brown
Mr R Robertson
MP Sauerman
Mr M Siebritz
Mr N Solomons
Mr RC Thompson
Mr JP Williams
Mr H Witbooi

Centre of Excellence for Invasion Biology

Mrs K Coombe-Davis
Dr S Davies
Ms D du Plessis
Dr M Gaertner
Ms A Garthwaite
MS M Koordom
Ms S Kritzinger-Klopper
Dr E Marais
Ms C Momberg
Ms R Moses
Ms E Nortje
Ms C Scheepers
MS M van der Vyver

Postdoctoral felows

Mhairi Alexander
Sara Andreotti
Madeleine Barton
Tristan Charles-Dominique
Marinus de Jager
Nina du Toit
Shelley Edwards
Jennifer Fill
Raquel Garcia
Delroy Guzha
Romina Henriques
Heidi Hirsch
Hans Kelstrup
Sabrina Kumschick
Michael Logan
Glenn Moncrieff
Natasha Mothapo
Tendai Musvuugwa
Ana Nunes
Ethel Phiri
James Rodgeer
Adelle Roux
Jiri Smid
Gary Ivan Stafford
Nicola Stevens
Daniel Vosloh
Katherine Watermeyer

DEPARTMENT OF CHEMISTRY AND POLYMER SCIENCE

The Department of Chemistry and Polymer Science is one of the pre-eminent research departments in chemistry in South Africa. We are engaged in a wide range of **research areas**, including the largest research effort in p**olymer science** in the country. It is also the only department at a South African university offering a BSc degree with a focus on **textile and polymer science**.

RESEARCH INTERESTS

Organic chemistry & medicinal chemistry	Inorganic chemistry & organometallic chemistry	Analytical chemistry
Polymer science	Physical & computational chemistry	Supramolecular chemistry & materials

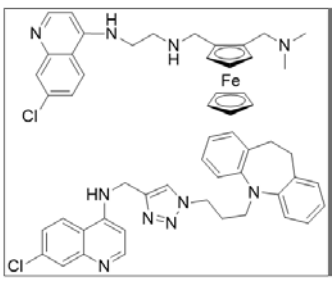
RESEARCH HIGHLIGHTS

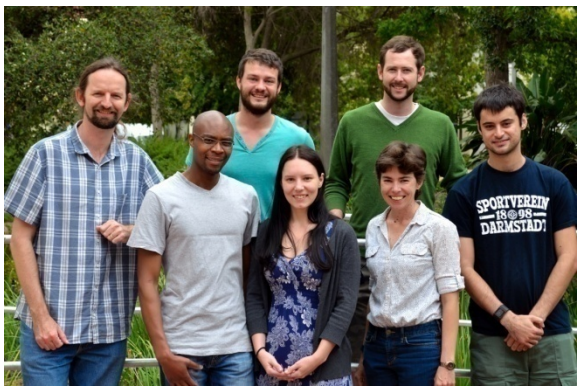
Medicinal and organic chemistry

Prof. Willem van Otterlo, chair of Organic Chemistry, and Dr Margaret Blackie (Antiplasmodials in action)

Research into various methods of combatting malaria have made significant strides in the last twenty years. Nonetheless, the rapid mutation of the five species of *Plasmodium* which cause malaria in humans means that drug resistance continues to emerge. In the last couple of years, the most worrying development of artemisinin resistance has been reported in South East Asia. So, the development of new drugs continues to be an important research thrust.

Over the past few years members of the Group of Medicinal and Organic Chemistry (GOMOC) have published several papers on novel antiplasmodial compounds. This includes the publication of two papers on quinolone-based antiplasmodials (see example below). In both series of compounds we were able to achieve good activity across both chloroquine sensitive and chloroquine resistant strains in a whole cell assay. Our focus area is the design and synthesis of new molecules containing known pharmacophores. In this case, the known pharmacophore is the quinoline which is known to inhibit haemozoin formation which results in a build-up of toxic haem in the parasite.





In the front, Prof. Willem van Otterlo, Mr Lebusetsa Taleli, Ms Monica Clements, Dr Margaret Blackie and Mr Anton Hamann. At the back, Mr Leon Jacobs and Mr Jonathan Hay.

Recently we have also begun to explore the possibility of using supramolecular interactions to enhance bioavailability of known antimalarials. This work is still in its infancy. A short review on what is currently known on multicomponent crystal systems and biological efficacy of compounds such as amodiaquine was published.

Copolymers for drug delivery and tissue engineering

Prof. Bert Klumpermann, SARChI research chair in Advanced Macromolecular Structures

Block copolymers are composed of two or more distinct blocks that differ in chemical composition. In many cases the polarities of the two blocks are significantly different. Such block copolymers can be used in many applications, ranging from drug delivery to hydrogels for tissue engineering. We prepared such block copolymers where one block is composed of poly(*N*-vinylpyrrolidone) (PVP), which is a well-known water-soluble polymer, and the other block is composed of a substituted analogue of PVP, i.e. poly(3-ethyl-*N*-vinylpyrrolidone) (PEVP). PEVP is known to be water-soluble below 27°C and water-insoluble above 27°C. As a consequence, the block copolymer self-assembles into aggregates when its aqueous solution is heated from room temperature to temperatures above circa 30°C. Figure 1 shows spherical and tubular aggregates of the block copolymer, where the morphology is solely controlled by the block polymer concentration in the solution.

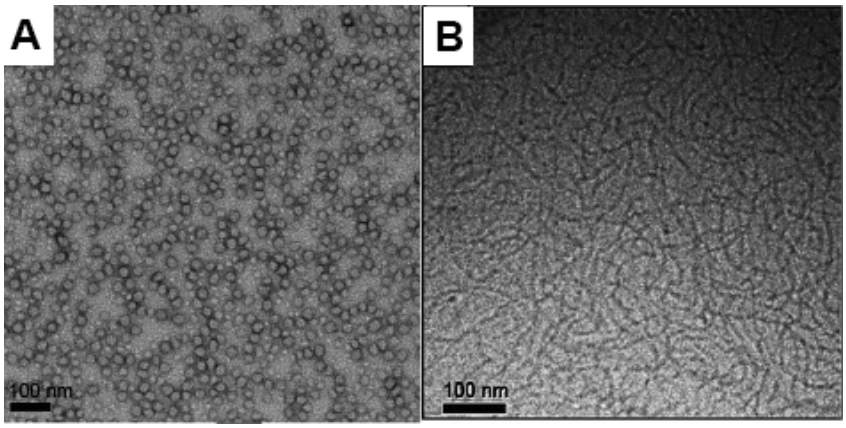


Figure1: TEM micrographs of poly(N-vinylpyrrolidone-b-3-ethyl-N-vinylpyrrolidone) block copolymers (PVP32-b-EPVP31)

Foldamers are polymers that change their conformation from a random coil into a well-defined helix upon application of a certain stimulus. We continued the investigation of so-called poly(*para*-aryl-triazole)s (pPATs) in mixed solvents and discovered a new supramolecular structure. Although the helices that form upon the addition of water to a *N,N*-dimethylformamide (DMF) solution of the pPATs have a diameter of less than 10 nm, superhelices are formed at high water contents. An example of these supramolecular structures as observed via electron microscopy and confocal fluorescence microscopy is shown in Figure 2. These polymers are used as biomimetic analogues to study the folding behavior of complex natural polymers such as DNA.

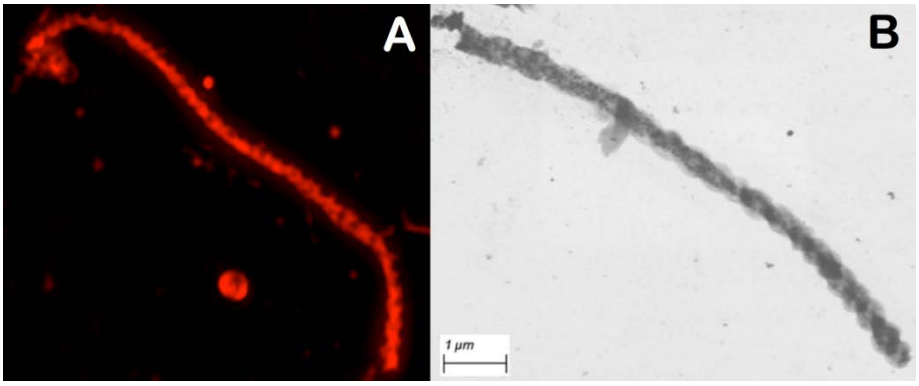


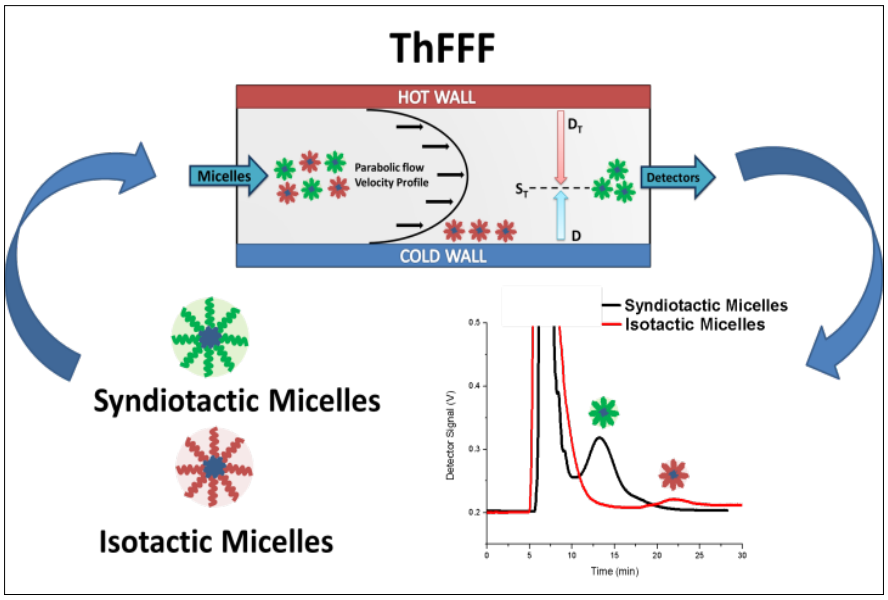
Figure 2: Supramolecular helices formed in DMF/water (40/60) solutions of poly(p-aryl-triazole) imaged via confocal fluorescence microscopy (A) and scanning transmission electron microscopy (B).

Multidimensional techniques for complex polymers

Prof. Harald Pasch (SASOL chair in Analytical Polymer Science) and Dr G Greyling

Research is focused on the development of multidimensional analytical techniques for complex polymers. This includes the coupling of different separation methods to each other (two-dimensional chromatography) and the hyphenation of separation methods with information-rich detectors like FTIR, NMR, and mass spectrometry. Separation methods to be used include all types of liquid chromatography, field flow fractionation, and fractionation methods based on crystallizability. Molecular parameters to be addressed are chemical composition distribution, functionality type distribution, and topology type distribution and their correlation with molar mass distribution.

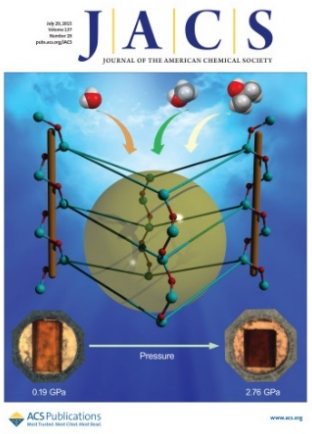
A special highlight in 2015 was the development of novel fractionation methods for the microstructure analysis of complex polymers and block copolymer micelles by PhD student Dr G. Greyling. Such selective fractionations are possible using thermal field flow fractionation, as has been shown for the first time. Field-flow fractionation (FFF) is a family of analytical techniques developed specifically for separating and characterizing macromolecules, supramolecular assemblies, colloids and particles. In thermal FFF, a temperature gradient is applied perpendicularly to the axial carrier liquid flow to achieve separation. Analytes are driven to the cold wall (accumulation wall) by their interaction with the applied temperature gradient. This mass transport is termed thermal diffusion, and is represented by the thermal diffusion coefficient (D_T), see Figure 1. The sensitivity of ThFFF towards chemical composition and microstructure has been demonstrated with the fractionation of polyisoprene, polybutadiene and polymethyl methacrylate regarding microstructure and tacticity (1-3). The same principle can be applied to the fractionation of block copolymer micelles which contain outer corona blocks having different tacticities. This is shown for polystyrene-block-polymethyl methacrylate (PMMA) micelles where the PMMA block is either syndiotactic or isotactic (4). It has also been demonstrated that ThFFF can be used to monitor the kinetics of micelle formation and exchange processes between micelles having different compositions (5).



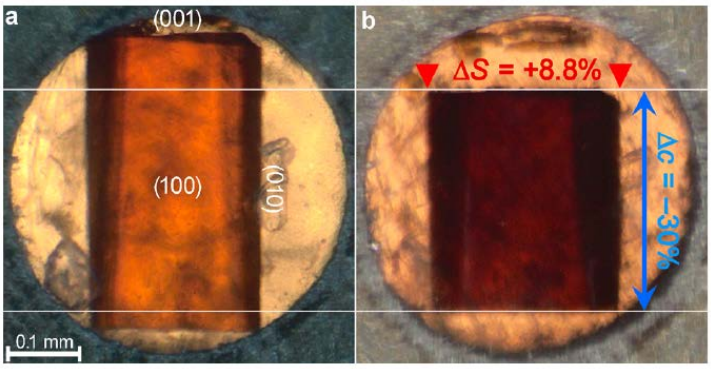
Thermal FFF fractionation of block copolymer micelles regarding tacticity of the corona block (4)

New piezo-responsive material

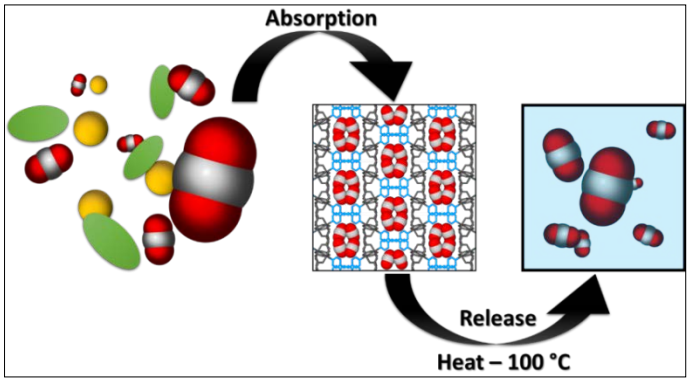
Prof. Len Barbour, SARChI chair in nano-structured functional materials



The article, "Giant Negative Area Compressibility Tunable in a Soft Porous Framework Material" was featured on the cover of the prestigious Journal of the American Chemical Society. In this article we describe a new piezo-responsive material (pressure-responsive) that not only displays the largest ever recorded piezo-mechanical response, it also displays tunability of this giant response depending on the medium in which it is being compressed. During hydrostatic compression, the material shrinks in one dimension while it expands in the other two. This is highly unusual behaviour as most materials shrink along all three directions. Few materials are known to expand in one direction and even fewer are known to expand along two. Piezo-responsive materials have utility in ultrasensitive sensors and actuators, though it is not envisaged that this material will have any direct application. The material was designed and synthesised by the Barbour group while the compressibility study was jointly undertaken as part of a collaboration with colleagues in Poland.



Furthermore, we reported a systematic study of three closely related microporous metal-organic frameworks (MOFs) whose pore dimensions vary according to the choice of bridging linker. The tuneable linker allows exploration of the effect of increasing pore dimensions on the carbon dioxide (CO_2) sorption behaviour of these materials. These three materials capture CO_2 under supercritical conditions and continue to hold onto the gas under ambient conditions. The material with intermediate pore size relative to the other two shows the greatest stability for CO_2 capture. The CO_2 sequestered with this material can readily be removed using temperatures less than 100°C which is already achieved in the relevant industrial processes. Computer simulations aided our understanding of the interactions responsible for holding the CO_2 gas molecules within the pores of the materials.

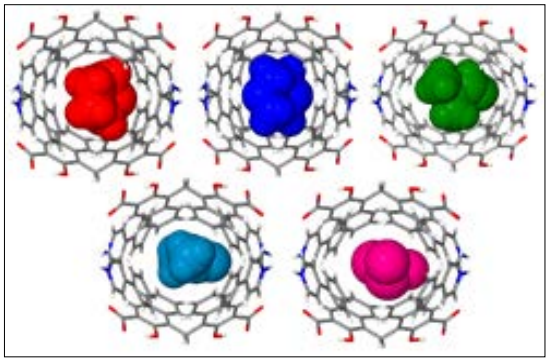


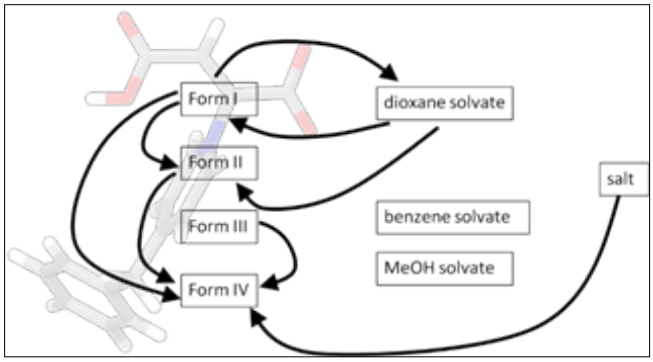
New host material from organic anions and cations

Prof. Delia Haynes and Dr Tanya le Roex, Organic Chemistry

Working on ionic organic materials in the solid state, we fully characterised a new host material constructed from organic anions and cations (LHS figure below). This material selectively includes dioxane in preference to other solvents.

We have also continued to investigate the solid-state behaviour of the novel zwitterions discovered recently in our laboratory. One of these zwitterions exhibits a remarkable number of forms: four polymorphs, three solvates and a salt (RHS Figure below). We have elucidated the relationships between these different forms, and clarified the conditions under which each is stable.

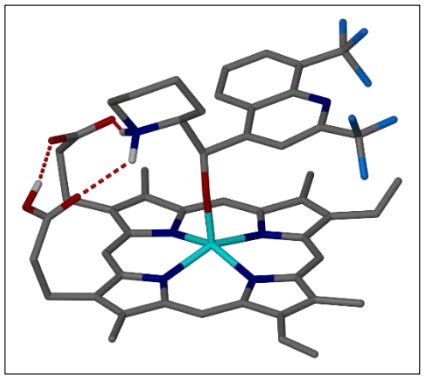




Novel drugs to combat malaria

Dr Katherine de Villiers, Bioinorganic research

Research is focused on understanding important structure-activity relationships that underpin the mechanisms of action of clinically-relevant antimalarial drugs. We are specifically interested in the haem (iron (III) protoporphyrin IX) detoxification pathway leading to the formation of malaria pigment, which is inhibited by drugs such as chloroquine. Through this work, our aim is to be able to contribute to the rational design of novel drugs, for which there is a pressing need owing to parasite resistance towards current treatments.



Single crystal X-ray diffraction structure of the coordination complex formed between the antimalarial drug mefloquine and haem.

A paper based primarily on Johandie Gildenhuys 2013 PhD, Co-supervised by Dr Tanya le Roex, was published in the international journal *Dalton Transactions* and titled "Alkoxide coordination of iron(III) protoporphyrin IX by antimalarial quinoline methanols: a key interaction observed in the solid-state and solution". Part of the work was carried out at the Australian Synchrotron (Melbourne) in collaboration with Dr Victor Streltsov from CSIRO. Valuable contributions towards the high-impact publication were also made by Dr David Kuter (post-doctoral fellow), Ronel Müller (PhD student) and Chandré Sammy (MSc student). Figure 1 shows the solid-state coordination complex formed from a non-aqueous solution of mefloquine and haem.

MSc student Sharné-Maré Fitzroy graduated *cum laude* in December 2015 for her thesis entitled "Towards the development of a medium-throughput assay to investigate the kinetics of β-haematin formation in the presence of diverse inhibitors" Research was funded via ongoing grants from the

National Research Foundation (Thuthuka) and the National Institutes of Health (United States of America).

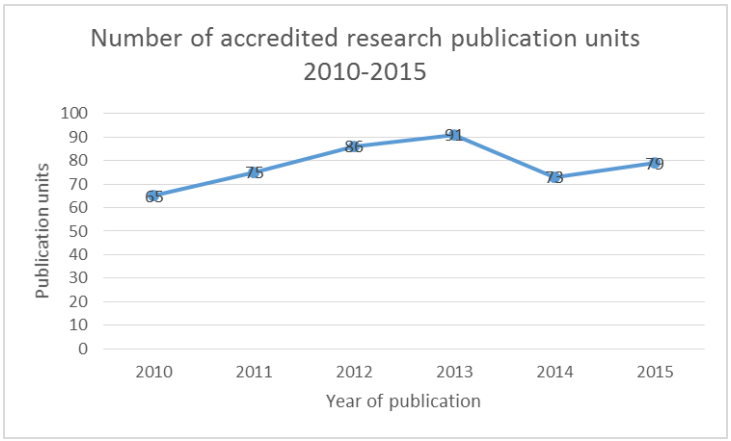
RESEARCH PROFILE

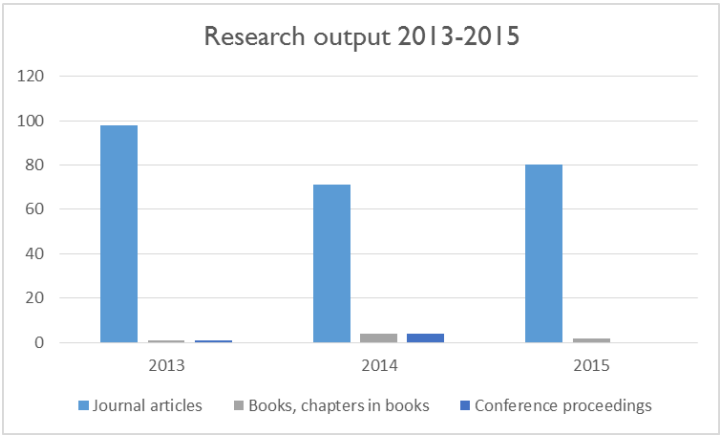
Research output

Currently 18 (60%) of academic staff members hold NRF-ratings and we are home to two of the four A-rated scientists in chemistry in South Africa – Prof. Bert Klumperman and Prof. Len Barbour. Prof. Klumperman and Prof. Barbour also hold two of the eight research chairs in the Faculty – the South African research chairs (SARChI) in Advanced Macromolecular Architectures and in Nano-structured Functional Materials.

The average age of our academic staff is only 47 years, which indicates that we are a relatively "young" department. All but one of our academic staff members hold a PhD degree.

Subsidised publications have steadily increased from 2010 to 2013, took a dip in 2014, but showed an upward swing again in 2015. We hope to see an increase on our previous year's publications in 2016. The majority of the articles are in international journals and some are in extremely high impact factor journals.



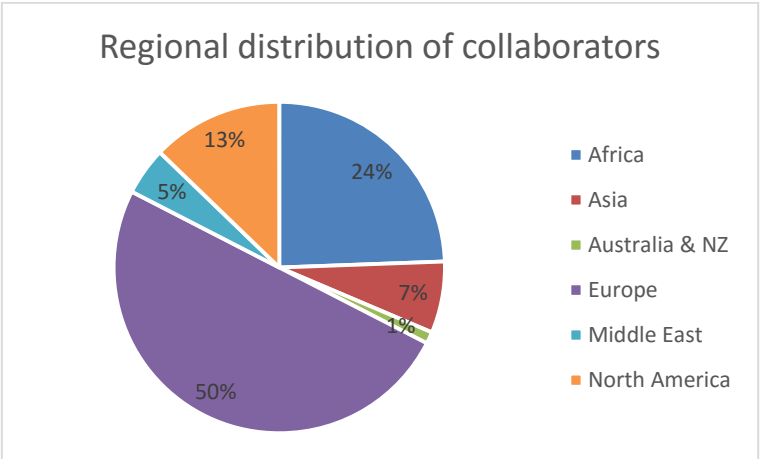


NRF-rated researchers

Leading international researcher	Prof. Bert Klumperman	Living radical polymerization and advanced macromolecular architectures
	Prof. Len Barbour	Functional nanostructured materials
Internationally acclaimed researcher	Prof. Ben Burger	Chemical communication in living organisms
	Prof. Harald Pasch	Analytical polymer science, multidimensional chromatography
	Prof. Willem van Otterlo	Organic synthesis and medicinal chemistry
	Prof. Helgard Raubenheimer	Ligand design aimed at applications in homogeneous catalysis; gold chemistry
	Prof. Klaus Koch	Multinuclear NMR spectrocopy and Platinum group metals chemistry
Established researcher	Prof. Peter Mallon	Complex polymer materials and polymer nano-composites
	Prof. Delia Haynes	Crystal engineering, Chemistry - Main group elements
	Prof. Selwyn Mapolie	Homogeneous catalysis via dendrimeric complexes
	Prof. Catharine Esterhuysen	Intermolecular interactions
	Prof. Ivan Green	Small molecules syntheses for medicinal application
	Prof. Ed Jacobs	Membrame and process development
	Prof. Albert van Reenen	Structure-property relationships
	Dr Robbie Luckay	Ligand design for metal ion coordination in industrial and medical applications
Promising Young Researcher	Prof. André de Villiers	Separation science fundamentals and applications
	Dr Gareth Arnott	Inherently chiral calixarenes; asymmetric methodology
	Dr Steven Pelly	Medicinal chemistry

Collaboration

During 2015 we collaborated with institutions from 25 countries – this includes co-authorship on research papers, research visits, staff and postgraduate student exchanges and other projects resulting from several bilateral agreements. While our footprint in South Africa (16) is large, we most often collaborated with institutions in Europe (particularly Germany) and the United States.



Other collaborations include:

Prof. Peter Mallon

- Collaborated with with Prof. Eric Dargent, LECAP lab, University of Rouen, France. Project: Properties of electrospun polymer nanofibres
- Collaborated with Giuliana Magnacca, University of Torino (Italy) and Marco Sangermano, Politecnico di Torino (Italy); Anonio Arques, Unviersitat Politecnica de Valencia (Spain); Vittorio Boffa, Aalborg University (Denmark); Vasilios Sakkas, University of Loannina (Greece); Marta Cerruti, McGill University (Canada); Luciano Carlos, Le Plata University (Argentina). Project: MAT4TREAT, Horizon 2020 (EU), Marie Sklodowska-Curie Project Research and Innovation Staff Exchange (RISE)

Prof. André de Villiers

- Collaborated with Prof. F Lynen, Department of Chemistry, University of Gent (Belgium). Project: Advances in liquid chromatography
- Informal collaboration with Prof. T Gorecki, Department of Chemistry, University of Waterloo (Canada). Project: Comprehensive 2-dimensional GC analysis of South African natural products

Dr Katherine de Villiers

- Collaborated on a three-way NIH-funded research project (2014-2018) with Prof. TJ Egan, University of Cape Town, and Prof. D Wright, Vanderbilt University (USA). Project: Plasmodium heme detoxification probes

Dr Njabu Gule

- Collaborated with Dr Thabile Ndlovu, Department of Chemistry, University of Swaziland. Project: Rural water purification using inexpensive easily accessible materials. A study targeting the water stressed Lowveld region of Swaziland
- Collaborated with Dr SP Malinga, Department of Applied Chemistry, University of Johannesburg, and Prof. Kim Larsen, University of Aalborg (Denmark). Project: Antifouling nanostructured membrane systems embedded with hyperbranched polymers as hosts for immobilisation of nanocatalysts and effective water remediation

Prof. Delia Haynes

- Collaborated with Prof. JM Rawson, Department of Chemistry and Biochemistry, University of Windsor (Canada); Prof. K Wozniak, University of Warsaw (Poland). Project: Novel materials from dithiadiazolyl radicals
- Collaboration with Prof. K Wozniak, University of Warsaw (Poland). Project: Charge density studies of dithiadiazolyl co-crystals
- NRF France/SA research cooperation with Dr N Claiser, Prof. C Lecomte and Prof. M Souhassou, Laboratory of Crystallography, Nuclear Magnetic Resonance and Modelling, Université de Lorraine (France). Project: Determination of spin-dependent electron density in dithiadiazolyl radicals

Adine Gericke and Dr Lizl Cronje

- Informal collaboration and international student exchange with Prof. A Demsar and Prof. K Dimitrovsky, Department of Textiles Faculty of Natural Sciences and Engineering, University of Ljubljana (Slovenia). Project: Textile science – post graduate student exchange programme

Adine Gericke

- Joint application for Horizons 2020 funding with Dr-Ing Petra Franitza, Lodz University of Technology LUT (Poland). Project: Stimulation of Interaction between Science and Society for better understanding the meaning of social factor in creating Responsible Research and Innovative Textile Products (SISStex)

Dr Lizl Cronje

- Informal collaboration with Prof. Henk Viljoen, University of Nebraska-Lincoln (USA). Project: A novel sampling technology for the treatment of paediatric tuberculosis

Prof. Bert Klumperman

- Co-supervision of students with Prof. AE Rowan, Radboud University, Nijmegen (Netherlands). Project: Polyisocyanide-based hydrogels
- Informal collaboration with Prof. JA Killian, Utrecht University (Netherlands). Project: Poly(styrene-co-maleic anhydride) for stabilization of nanodiscs
- Collaboration with Prof. C Barner-Kowollik, Karlsruhe Institute of Technology (Germany). Project: Surface characterization of modified nanofibers
- Prof. A Laaksonen, Stockholm University (Sweden). Project: Modelling of polymer self-assembly
- Dr JPG Sluijter, Utrecht Medical Center (Netherlands). Project: Delivery of miRNA therapeutics

Prof. Catharine Esterhuysen

- Collaboration with Prof. G Frenking, Philipps-Universität Marburg (Germany). Project: The computational analysis of carbones
- Collaboration with Prof. FM Bickelhaupt, Vrije Universiteit Amsterdam (Netherlands). Project: Computational analysis of Au-containing complexes

Dr Marietjie Lutz

- Collaboration with Prof. L Tichagwa, Harare Institute of Technology, Department of Polymer Science, University of Harare (Zimbabwe). Project: The modification of natural polymers such as lignocellulose, cellulose, chitosan and clays in order to convert the polymers into low cost and "smart materials" like nano-composites with improved properties for various applications

Prof. Len Barbour

- NRF Bilateral agreement, Dr Consiglia Tedesco, Department of Chemistry, Ulsan National Institute of Science and Technology (South Korea). Project: Synthesis and characterisation of porous molecular solids
- NRF Bilateral agreement, Prof. Wonyoung Choe, Department of Chemistry, Ulsan National Institute of Science and Technology (South Korea). Project: Synthesis and in-situ characterisation of porphyrinic metal-organic frameworks for gas capture
- Stellenbosch/Bath inter-university collaboration, Drs Janet Scott, Karen Edler and Lynne Thomas, Department of Chemistry, University of Bath (UK). Project: Porous materials

Prof. Selwyn Mapolie

- Informal continuation of a former NRF/Bilateral Agreement with Prof. Ebbe Nordlander, Department of Chemical Physics, Lund University (Sweden). Project: Development of novel catalysts based on PGM's
- Informal collaboration with Dr Archana Bhaw-Luximon, Centre for Biomedical and Biomaterials Research, University of Mauritius. Project: Ring opening polymerization of lactides using transition metal catalyst

Prof. Willem van Otterlo and Dr Steven C Pelly

- NRF Bilateral agreement – Italy-RSA, with Prof. Antonio Evidente, Dr A Crimmino, Dipartimento di Scienze Chimiche, Università di Napoli Federico II, Complesso Universitario Monte S. Angelo, Via Cintia 4, 80126 Napoli, Italy. Project: Isolation and chemical and biological characterization of metabolites from South African bulbs
- Prof. Dr D Rauh, Department of Chemistry and Chemical Biology, Technical University Dortmund, Dortmund (Germany). Project: Synthesis of irreversible kinase inhibitors
- Prof. A Kornienko, Department of Chemistry and Biochemistry, State University Texas, San Marcos, Texas (USA). Project: Biologically inspired cytotoxic agents
- Prof. R Kiss, Prof. V Mathieu, Prof. F Lefranc, Laboratorie de Cancérologie et de Toxicologie Expérimentale, Faculté de Pharmacie, Université Libre de Bruxelles (ULB), Brussels (Belgium). Project : Evaluation of novel cytotoxic agents

Prof. Willem van Otterlo

- Prof. L Brunsveld, Department of Chemical Biology, Technical University Eindhoven, Eindhoven, The Netherlands. Project: Synthesis of THIQ-based selective estrogen receptor modulators

Dr Margaret Blackie

- Prof. J Franco, Department of Chemistry, Merrimack College, Massachusetts, (USA). Project: Evaluation of known compounds as antimalarial agents
- Prof. M Pollastri, Department of Chemistry, Northeastern University, Massachusetts (USA). Project: Use of large datasets in drug discovery for neglected tropical diseases
- UK-SA collaboration with Prof. P Ashwin Lancaster University, Dr J McArthur, Lancaster University, Prof. J Case, University of Cape Town. Project: Understanding Knowledge, Curriculum and Student Agency

Prof. Harald Pasch

- NRF-bilateral Chinese Academy of Sciences: Prof. Yonggang Liu, Changchun Institute of Applied Chemistry (China). Project: Preparation and characterization of chitosan-decorated liposomes for drug delivery
- Dr Volker Joerres, Novolen, Mannheim, Germany. Project: Development of analytical methods for complex polyolefins
- Dr Celine Farcet, L'Oreal, Paris, France. Project: Characterization of natural polymers for cosmetic applications
- Dr S Udomsak, SCG Chemicals (Thailand). Project: Functional group analysis in polyolefin waxes
- Informal collaboration: Dr W Hiller, Dr M Hehn, Technical University Dortmund, Germany. Project: LC-NMR coupling for the analysis of complex polymers
- Informal collaboration: Dr T Klein, Dr T Howard, Postnova Analytics, Landsberg, Germany. Project: Field Flow Fractionation for polymer separation
- Informal collaboration: Prof. A Pizzi, Université Henri Poincaré - Nancy I (France). Project: Analytical methods for tannine derivatives

Prof. Klaus Koch

- Collaboration with Prof. A Laaksonen, Arrhenius Institute, Stockholm University (Sweden). Project: Modelling of solvation and hydration effects in Platinum complexes as seen in 195Pt NMR.
- Prof. Michael Buehl, Depertment of Chemistry, St Andrews University (Scotland). Project: Computations of Isotope effects in 195Pt NMR
- Prof. Wolf Hiller, Dortmund University (Germany). Project: High-level NMR collaboration with a mobility grant from the NRF. I and a student will visit Germany for high-level HPLC-NMR in June 2015
- Dr Renat Hans, University of Namibia, Windhoek (Namibia). Project: Capacity building of NMR spectroscopy for bio-prospecting of potentially active molecules in plants. Bilateral agreement two years 2014 -2016
- Prof. E Hey-Hawkins, Prof. S Berger, University of Leipzig (Germany). Project: Longstanding collaboration and exchange program with the Department of Chemistry

Funding

South Africa

Claude Leon Foundation
Department Of Science and Technology South Africa
National Research Foundation (NRF)
Sasol South Africa
South African Research Chairs Initiative SARChI, Department of Science and Technology (DST)
Stellenbosch University
University of Cape Town
University of Kwazulu-Natal
University of the Witwatersrand
Water Research Commission

International

BMBF Bundesministerium fur Bildung und Forschung, Germany
Canon Collins Trust, United Kingdom
International Centre of Macromolecules and Materials Science, Libya
Lummus Novolen Technology GMBH Germany
National Cancer Institute, United States
National Institute of General Medical Sciences, United States
National Science Foundation, United States
University of Rouen, France
Welch Foundation, United States

Awards

Our researchers continue to gain recognition through awards or from publications in the literature. The following were some of the awards and recognition of our researchers for 2015.

- Prof. Bert Klumperman, 2015 SASOL Chemistry Innovator of the Year medal; appointed as editor of Transactions of the Royal Society of South Africa; Finalist in 2014/2015 NSTF-BHP Billiton Awards (Over a lifetime achievement by an individual)
- Prof. André de Villiers, Winner of South African Chemical Institute (SACI) Raikes medal for 2015 (awarded to an outstanding researcher under the age of 40 as determined by their published research output)
- Prof. Delia Haynes, Winner of the Jan Boeyens Prize from the South African Crystallographic Society for making a distinguished contribution to the use of crystallography and other structural methods in a holistic manner to investigate fundamental problems in Nature.
- Prof. Harald Pasch was awarded the SU Chancellor's Award for outstanding achievement during the December 2015 graduation ceremony. Prof. Pasch joined SU in 2008 as holder of the SASOL research chair and head of the Polymer section. Over the next seven years he developed the analytical chemistry group in the Department of Chemistry and Polymer Science into an internationally recognised centre of excellence for advanced polymer analysis. With more than 300 peer-reviewed articles behind his name, his present research focuses on multidimensional liquid chromatography, advanced spectroscopy, the development of analytical methods for nanomaterial, and high-throughput experimentation. He has supervised more than 50 postgraduate students in Germany and South Africa.
- Prof. Peter Mallon was elected as Executive Secretary of the South African Chemical Institute (SACI) for a two- year term.

Academic activities

Our researchers presented at national and international conferences during 2015 and we were well-represented at national conferences with several of our academics and students presenting papers. Most notable was that at the South African Chemical Institute's (SACI) Convention held in Durban in December 2015, three researchers presented plenaries which were linked to awards. They were Prof. Len Barbour (invited plenary), Prof. Bert Klumperman (Sasol Innovation award) and Prof. André de Villiers (Raikes Medal).

During 2015 the Department hosted two international conferences:

The **annual conference of the Catalysis Society of South Africa** (CATSA 2015). Prof. Mapolie chaired the organising committee, while Dr Malgas-Enus was the treasurer and responsible for marketing and Ms Sylette May was the secretary. The conference theme was "Shaping our world through catalysis". The conference took place at the Arabella Hotel and Spa in Kleinmond from 15-18 November 2015. Around 230 delegates attended and just under half were postgraduate students. There was one main plenary, a keynote, invited lectures and a poster session. Delegates were mainly from South African industry and academia, with international delegates from several countries. At this conference, a social event involved chemists competing

Students from the Department of Chemistry and Polymer Science assisting at the CATSA 2015 conference. From the left, Ené Slazus, Laura Leckie and Tsepiso Khutlane.

against engineers in a version of the popular game "A minute to win it" with the chemists being victorious.

The **13th Unesco/IUPAC Workshop and Conference on Macromolecules and Materials** took place in Port Elizabeth from the 7-10 September 2015. Prof. Albert van Reenen was chairperson for this conference and Ms Aneli Fourie the secretary. This is an annual international conference with approximately 100 delegates attending. Roughly 50% were local and the other 50% were from SADC countries. There were seven plenary sessions and a poster session, as well as a meet-and-greet function and a conference dinner.

Service to the scientific community

Editorial activities

Prof. Len Barbour
Comprehensive Supramolecular Chemistry, a proposed nine volume reference work (Elsevier) (Co-editor in chief); *New Journal of Chemistry* (editorial board)

Prof. Willem van Otterlo
South African Journal of Chemistry (editor)

Prof. Bert Klumperman
European Polymer Journal (editor); *Transactions of the Royal Society of South Africa* (editor-in-chief & editorial advisory board)

Prof. Harald Pasch
International Journal of Polymer Analysis and Characterization (IJPAC) (editorial board); *Polymer International* (PI) (editorial board); Springer Laboratory book series (editor)

Other activities

Dr Gareth Arnott
Western Cape Branch of the South African Chemical Institute (committee member); National Research Foundation Thuthuka and Blue Skies panel member; NRF Competitive Programme for Rated Researchers panel; NRF Competitive Support for Unrated Researchers panel

Prof. André de Villiers
Western Cape Board of the Chromatographic Society of South Africa (ChromSA) (chair)

Prof. Catherine Esterhuysen
South African Crystallography Society (SACrS) (president); International Union of Crystallography Congress (South African representative)

Prof. Klaus Koch
International Conference on Coordination Chemistry (SA representative on executive planning committee)

Prof. Bert Klumperman

Royal Dutch Chemical Society (member); American Chemical Society (member); South African Chemical Institute (member); International Society for Biomedical Polymers and Polymeric Biomaterials (member); Council of the Royal Society of South Africa (member); Nanotechnology/drug and vaccine development at the African Cancer Institute (focus area champion)

Dr Rehana Malgas-Enus
National Research Foundation Innovation and Free-standing PhD and Postdoc applications (panel)

Prof. Peter Mallon Western Cape Section of the South African Chemical Institute (chair); 22nd World Forum on Advanced Materials POLYCHAR 22 (chair of the organising committee); National Council of the South African Chemical Institute (SACI) (member); International Scientific Committee of the World Forum on Advanced Materials (POLYCHAR) (member); NRF Blue Skies review panel (member)
Prof. Selwyn Mapolie Catalysis Society of South Africa (executive committee)
Prof. Harald Pasch International Symposium on Polymer Analysis and Characterization (governing board)
Dr Ruben Pfukwa National Research Foundation Doctoral Scholarship Program (panel); National Research Foundation SA-Romania Research Cooperative (panel); South Africa-United Kingdom Scientific Seminar (organiser)
Prof. Albert van Reenen World Forum on Advanced Materials Conference POLYCHAR 22 (local organiser)

SOCIAL IMPACT

The Stellenbosch University Chemistry Outreach Initiative (SUNCOI)

The primary goals of this outreach program are to:

- provide much needed infrastructure support by offering students and their teachers the necessary laboratory environment to work in on the SU campus,
- develop a deeper understanding of the conceptually challenging topics of their prescribed syllabus (through the project: *SUNCOI Practicals with Purpose*).
- collaborate with the Faculty of Education through involvement of pre-service teacher education students in practical work with in-service teachers and their learners as well as postgraduate chemistry students and chemistry lecturer/researchers (through the project: *SUNCOI Teaching the Teacher the Nuts and Bolts of Chemistry).*

During 2015, SUNCOI hosted four disadvantaged schools for the prescribed chemistry practicals. On Saturday, 7 March 2015, the Department of Chemistry and Polymer Science hosted the prescribed Grade 12 practicals – *Synthesis of Esters* and *The titration of oxalic acid against sodium hydroxide to determine the concentration of the sodium hydroxide*. On Saturday, 16 May 2015, SUNCOI presented the prescribed Grade 11 practical, namely *Intermolecular Forces*. Grade 11 pupils from four disadvantaged schools, Cloetesville High, Kylemore High, Pelican Park High and Zeekoevlei High, attended. On Saturday, 12 September 2015, the prescribed Grade 10 practical, *Reactions in Aqueous Solutions*, were attended by 100 Grade 10 learners from four disadvantaged schools, Cloetesville High, Kylemore High, Pelican Park High and Zeekoevlei High.

Postgraduate chemistry students volunteered to demonstrate experiments and supported learners. Pre-service educator (PGCE) students from the Faculty of Education were included in all of these practical workshops. Each intervention lasted for five to eight hours and included two hours of pre-practical lectures covering aspects such as the theoretical concepts of the experiments to be performed as well as safety precautions. This was followed by three hours of practical exercises in the case of the Grade 11 and Grade 10 practicals and five hours in the case of the Grade 12 practicals. Advanced African Technologies (AAT) sponsored the chemicals and consumables, the

Division of Community Interaction at SU sponsored the transport and McDonalds Stellenbosch sponsored lunch to all students and staff members.



Teaching the Teacher the Nuts and Bolts of Chemistry

This annual teacher training programme is focused on current in-service teachers. The project creates a space for the Western Cape Education Department (WCED) to use SU's chemistry labs for training of in-service teachers in collaboration with chemistry specialists in the discipline. A "SUNCOI Teaching the Teacher the Nuts and Bolts of Chemistry" content mentoring workshop was held on 28 November 2015. 60 teachers from the Cape Winelands and the Metropole South District schools were in attendance.

AlchemUS chemistry society

AlchemUS, together with the department of Chemistry and Polymer Science, started 2015 off with their (in)famous potjiekos competition to welcome the new honours students to the department.

Later in the term AlchemUS arranged for a guest speaker, Dr Jaisheila Rajput, to tell her tale of how she went from a PhD in organic chemistry to CEO of her own company, TOMA-Now. At a second lunch-time guest lecture, specifically aimed at third year students, Ms Roxanne Dode, a recent BSc graduate, talked about current research and development at Unilever and answered questions about finding a job after graduating.



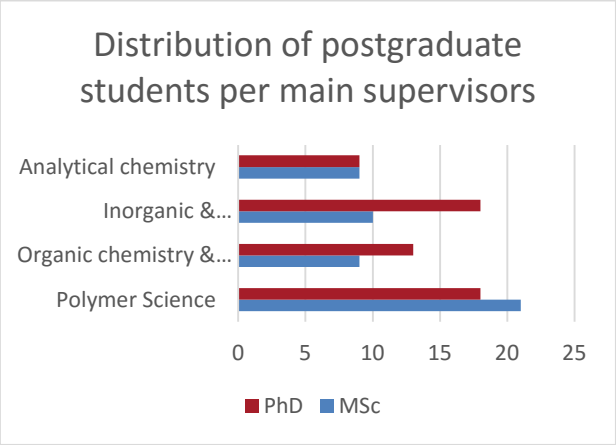
The biannual Pub Quiz was hosted by Prof. Mallon. Spot prizes were awarded to various teams for funny, interesting and bizarre answers, while the winning team – a group of MSc students – were awarded a small bar tab and bragging rights for the following six months.

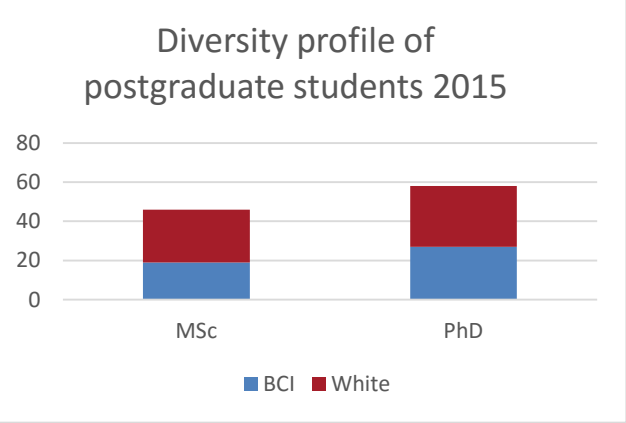
The annual highlight is the magic show, aimed at young children to make them think about chemistry and how it fits into their world. This year's production was entitled "Minions: the molecular masters" and included flames, liquid nitrogen and many other cool science experiments. After the show, children asked questions about the experiments. High school learners enjoyed a short guided tour of some of the research laboratories.

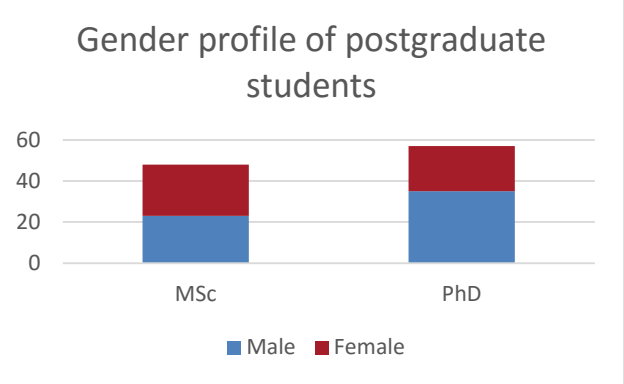
ACADEMIC AFFAIRS

Focus on postgraduate students

The Department has a large cohort of 109 full-time postgraduate students – 49 MSc and 60 PhD students. During 2015 we delivered 20 MSc and 11 PhD graduates. The Department was also host to 19 postdoctoral fellows from South Africa (9), India (3) and the rest from Italy, Libya, Lesotho, Germany, Namibia, Zimbabwe and China.







From left to right, Prof. Peter Mallon (Head of Department), Jean Lombard, Chandré Smit, Luca Bertossi, Annerike Cronje, Marisa Valentine, Jana Botha and Prof. Louise Warnich (Dean: Faculty of Science). Photo: Wiida Fourie-Basson

Our postgraduate students also performed well at conferences and with awards:

- Jean Lombard was awarded the SMM award for the best chemistry honours student
- Chandré Smit and Luca Bertossi shared the Element Six (Pty) Ltd DST/NRF Centre of Excellence Award for the best third year student in chemistry (including polymer modules)
- Annerike Cronje received a book prize for the best second year student in 2015
- Jana Botha received the Merck award for the best final year chemistry student in 2015, as well as the award for the best marks in second and third year analytical chemistry.
- S-M Fitzroy won second place in the poster competition at the 2015 SACI Inorganic Chemistry Conference

Staff matters

Dr. Maritha le Roux retired as senior lecturer as from 31 December 2015, after 16 and a half years of service (July 1999 – December 2015). Prof. Albert van Reenen was promoted to Professor from 1 January 2015 and Prof. Peter Mallon was promoted to Professor from 1 January 2016. We welcome Dr Prinessa Chellan, who joined us as lecturer from 1 January 2016.

Bursary fund to honour Prof. Sanderson's legacy

The late Prof. Ron Sanderson's legacy will be honoured in the form of a bursary fund for honours students in polymer science at Stellenbosch University (SU).

Prof. Sanderson was appointed at the Department of Chemistry at SU in 1970. At the time he was the only polymer scientist in South Africa and the discipline was virtually non-existent as an academic field in Africa. Over the next 40 years he did ground-breaking work to establish polymer science as a research and teaching discipline at Stellenbosch University. Prof. Sanderson passed away in August 2015 at his home in Somerset-West.

The aim of the bursary fund will be to create a sustainable source of financial support for one or two deserving students registered for the BSc Honours (Polymer Science) degree at SU. The fund has already received contributions from Kansai Plascon and Safripol since its establishment on 21 August 2015.

Staff list

Head of department

Prof. PE Mallon

Academic staff

Dr GE Arnott
Prof. LJ Barbour
Dr MAL Blackie
Dr L Cronje
Prof. AJ de Villiers
Dr K de Villiers
Prof. JLM Dillen
Prof. C Esterhuysen
Dr WJ Gerber
Ms A Gericke
Prof. DA Haynes
Prof. EP Jacobs
Prof. L Klumperman
Prof. KR Koch
Dr T le Roex
Dr M le Roux *(retired December 2015)*
Dr RC Luckay
Dr M Lutz
Dr R Malgas-Enus
Prof. SF Mapolie
Prof. H Pasch
Dr SC Pelly
Dr L Retief *(contract ended Dec 2015)*
Dr I Rootman-le Grange *(Contract ended Dec 2015)*
Prof. WAL van Otterlo
Prof. AJ van Reenen
Dr PFM Verhoeven
Dr R Pfukwa
Dr NP Gule
Dr VJ Smith
Dr AGJ Tredoux
Prof. WM Mackenroth
Prof. A Rowan
Prof. IR Green
Dr AE Smit
Prof. BV Burger
Prof. HG Raubenheimer

Support staff

Mr JG Goldie
Ms LD Bailey *(resigned)*
Mr M Bickerstaff
Ms MMG Cooper
Ms DM Davids
Ms M du Plessis
Ms AE Fourie
Ms C Hendrickse
Ms DM Isaacs
Ms MC Johnson
Mr RD Lawrence *(resigned)*
Mr CW Maart
Mr MG Marupula
Ms SG May
Ms CJ van Reenen
Mr A van Zaal *(resigned)*
Ms DC Wenn
Mr GR Willemse

Technical staff

Mr WJ Adonis
Mr MC de Jongh
Mr JD Groenewald
Mr DJ Koen
Mr EJ Lukhele
Mr MA McLean
Mr S Mohamed
Mr JS Motshweni
Dr NO Pretorius *(resigned December 2015)*
Mr J Smit *(resigned April 2015)*
Ms PJ Steyn

New appointments

Dr P Chellan *(academic)*
Mr. K B Mbalo (technical)
Mr. A Nxopo *(technical)*
Ms. M Jones *(support)*

DEPARTMENT OF EARTH SCIENCES

The Department of Earth Sciences is one of the oldest academic departments at Stellenbosch University, with a history that goes back to the teaching of 'elementary geology' at the Stellenbosch School from 1840 to 1865. Today the Department maintains a prominent position in the fields of petrology, geochemistry, structural geology and tectonics.

RESEARCH INTERESTS

Geology

- Tectonics and orogenic processes
- Sedimentology and palaeontology
- Igneous petrogenesis
- Metamorphic petrology
- Experimental petrology
- Shear-zone hosted gold deposits
- Massive sulphide deposits
- Heavy mineral placer deposits
- Metallogenesis of mobile belts

Environmental geochemistry

- Trace-element and isotope geochemistry
- Marine geochemistry
- Hydro-geochemistry
- Pollution
- Paleo-reconstruction

RESEARCH HIGHLIGHTS

New insights into the gigantic Donkerhuk granite batholith

Prof. John Clemens

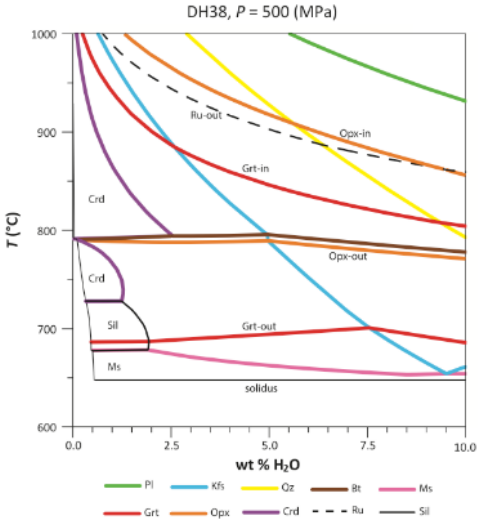
The gigantic Donkerhuk granite batholith in Namibia is 200 kilometres long, 25 to 50 kilometres wide and at least one kilometre thick – a daunting subject for any geologist wanting to try and understand the geological evolution of this massive piece of granite.

Profs John Clemens, Alex Kisters and Ian Buick and a group of honours students are now in the final stage of a three-year NRF-funded study to understand the conditions under which the magmas were formed and their mode of emplacement as thousands of magma sheets into the surrounding Kuiseb Formation. The work, over three field seasons, has involved mapping, geochemical sampling, computer modelling of mineral assemblages, chemical and isotopic analysis and U-Pb dating of the minerals in the rocks.

One of the interesting findings thus far is that emplacement occurred only slightly higher in the crust (at a depth of about 15 km) than where they were formed (at about 20 km). This is now understood in terms of the geological structures that prevented the Donkerhuk magmas from moving to shallower levels. What remains to be worked out is how this extremely heterogeneous and long-lived (perhaps about 20 million years) plutonism fitted into the overall tectonic development of the

Damara Belt in the Early Cambrian, around 530 million years ago. While volcanic rocks form when magma cools and solidifies on Earth, plutonic rocks form when magma cools and solidifies below the Earth's surface.

Prof. Ian Buick and Prof. Alex Kisters with their German collaborator Prof. Stefan Jung from the University of Hamburg, doing field work on the Donkerhuk batholith in Namibia. Photo: John Clemens



Calculated pseudosection used to determine the pressure, temperature and H_2O content of one of the Donkerhuk granitic magmas during its early crystallisation. Image: John Clemens

Rcrust – A new tool for calculating path-dependent processes and application to melt loss

Prof. Gary Stevens

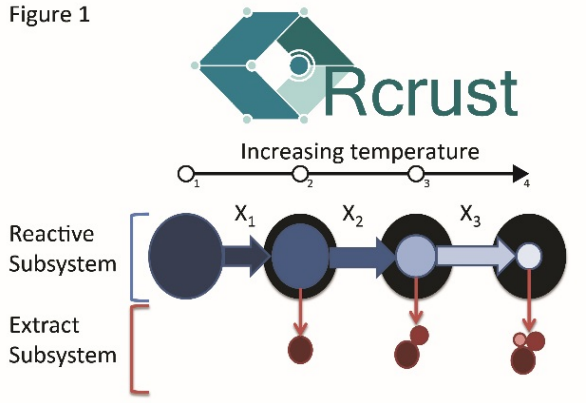
Large databases of rock compositions obtained from field observations coupled with experimental results from the laboratory have allowed the compilation of internally consistent thermodynamic datasets. 'Phase equilibria modelling' utilises this thermodynamic data to predict the stability of phases (minerals, fluids, etc.) under given conditions. This provides a powerful tool for geologists to determine the pressure and temperature under which the rock was formed.

However, there are limitations to this approach. One of the assumptions made by conventional thermodynamic modeling techniques is that the system under study is in equilibrium with a fixed homogenous bulk composition. In other words, we assume that all portions of the rock are in constant contact with all other portions and can be represented by one overall chemical composition (the bulk composition).

This is in stark contrast to the natural system where rocks are segregated into separate portions during melting or where potions of rock are isolated from each other by chemical gradients. In order to better study these systems, MSc student Matt Mayne created a software tool called Rcrust, which aids in investigating the effects of a changing bulk composition. This tool allows us to map rock-forming processes as a collection of 'dependent-paths' in pressure-temperature-bulk composition space.

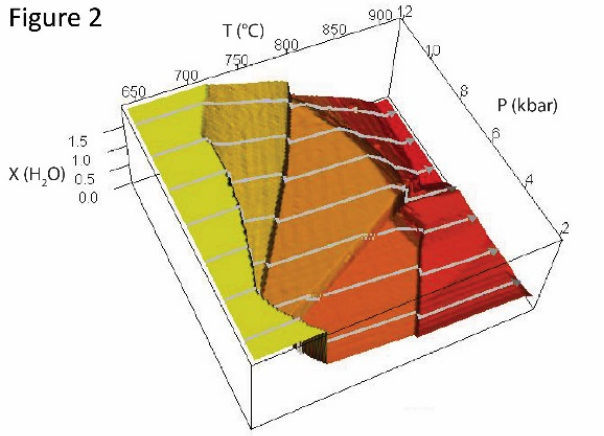
Rcrust creates this 'path-dependence' by following an iterative approach illustrated in Figure 1. This new tool will greatly assist in studies of bulk compositional change, for example, in investigating the effects of melt loss on the water content of a rock.

Figure 1



The path-dependent iteration approach of the software tool Rcrust. The reactive subsystem is the portion of the rock that is kept in thermodynamic equilibrium with the given conditions. The bulk composition (X) of the reactive subsystem is passed between points of increasing temperature. Melt is extracted when set criteria are met, resulting in a changing bulk composition for the reactive subsystem.

Figure 2



A compilation of dependent paths showing the effects of melt loss on the water content, X(H_2O), of a rock. Our model suggests that conventional thermodynamic modelling techniques are overestimating the amount of melt that natural rock systems can produce.

Palaeosciences at Stellenbosch University

Dr Ryan Tucker

With expertise in sedimentary environments, chemical tracers of sedimentary provenance (e.g., detrital zircon geochronology; Lu-Hf isotopes), and palaeontology, questions about the fossil record and the evolution of sedimentary basins in South Africa and internationally, are being adressed.

We specifically focus on questions concerning: 1) development of new strategies for improving the depositional age of clastic stratigraphic successions through the application of detrital mineral geochronology; 2) timing and pattern of basin development in Gondwana during the Late Paleozoic to Mesozoic; 3) vertebrate taphonomy; and 4) vertebrate palaeontology.

Key projects are with collaborators at the University of the Witwatersrand (Zubair Jinnah and Bruce Rubidge) and the University of Cape Town (Anusuya Chinsamy-Turan and Emese Bordy). On international level we work with the Los Angeles County Museum of Natural History (Luis Chiappe) and the North Carolina Museum of Natural Sciences (Lindsay Zanno).

Current projects:

Multi-disciplinary project to refine the regional and temporal distribution of trace fossils in the southern African Triassic-Jurassic Boundary

This is a multi-proxy, multidisciplinary project in collaboration with the University of Cape Town that focuses on the heart of the Triassic-Jurassic Boundary Karoo sediments (Elliot and Clarens formations) of Lesotho. The fluvio-lacustrine and aeolian rocks of the Triassic-Jurassic Elliot and Clarens formations preserve a broad suite of vertebrate body and a plethora of trace fossils. These ancient life remains and their mode of preservation in the host sediments can be used to

An archosaurian track (trace-fossil) from west-central Lesotho. Photo: Ryan Tucker

decode messages about the dynamics of a ~200 million years old palaeoecological system in southern Africa. This assemblage may also provide crucial assistance in (a) placing of the Triassic-Jurassic Boundary in southern Africa and (b) constraining the correlation with other sites of global significance (e.g., Canadian Fundy Basin). We aim to refine the regional and temporal distribution of trace fossils in the southern African TJB succession and establish the fundamental building blocks for an ichnological framework. Increasing the temporal resolution of the Triassic-Jurassic ichnotaxonomy in southern Africa will provide an unparalleled opportunity for comparison of local occurrences to global sites, in addition to marking temporal changes in the palaeofauna (and specifically in the ichnofauna) both locally in southern Africa and globally. Given that the TJB marks one of the Earth's largest mass extinction events, establishing the geological events and changes that occurred prior and during Early Jurassic in Southern Africa has a potential to generate new knowledge on the Earth's history (e.g., causes of the mass extinction event; tempo and adaptation strategies of the biota) on regional and global scale.

South Africa's Jurassic terrestrial floral taxa

The study of a unique deposit in the Lebombo Group lavas, exposed in Kruger and Limpopo National Parks, seeks to elucidate possible sedimentological and palaeoecological context for a "recently discovered" floral assemblage preserved within the Lebombo Group lavas. This fossil record is also particularly intriguing because its age coincides with a minor global extinction event. Furthermore, this 'in-situ' assemblage seemed to have thrived in the middle of this large Igneous province (LIP) during highly active volcanism; a quite rare occurrence. The study aims to provide contextual information to address intriguing questions: chiefly, how a forest was thriving in a violent and chaotic volcanic area, when LIPs are generally believed to cause mass extinctions? This could be crucial to our understanding of how South Africa's Jurassic terrestrial floral taxa thrived not only in a hostile environment, but also during a minor global extinction event. Based on work conducted in 2015, we have resolved that these uniquely preserved structure assemblages are in-fact the altered remains of paleofloral remains (twigs, leaves, and bark). This represents a 'Pompeii-like' preservation, which has yet to be reported from any South African fossil assemblage.

SU student working on fossil assemblages site in Kruger National Park

International projects

On the international level, projects seek to foster the development scientific based skill set for students. A collaborative project with the Los Angeles County Museum of Natural History (Luis Chiappe) will investigate the newly discovered remains of a *Tyrannosaurus rex* (Dinosauria) entombed within the sediments of the Ojo Alamo and Kirtland formations of New Mexico. Another project seeks to contextualize both historical and recently discovered dinosaur assemblages in the Cedar Mountain Formation of Utah with the North Carolina Museum of Natural History. These projects will offer postgraduate students a unique opportunity to work in collaboration with some of the world's foremost palaeoscientific researchers.

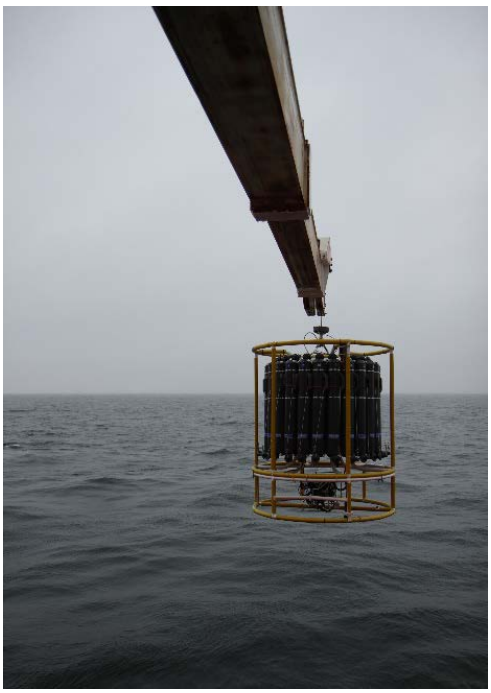
Trace metals and phytoplankton production in the Southern Ocean

Prof. Roy Roychoudhury and Dr Susanne Fietz

Several multidisciplinary projects focus on understanding the evolution of Southern Hemisphere marine and coastal ecosystems. The Southern Ocean in particular plays an important role in global climate change. Even small changes in the production of phytoplankton in the Southern Ocean will influence carbon dioxide uptake and release. This will in turn influence global atmospheric carbon dioxide concentrations, surface temperatures, ocean acidification and climate.

Trace metals play a central role in several vital phytoplankton cellular processes including photosynthesis. However, large sectors of the Southern Ocean below Africa lack scientific data that will help better understand linkages between trace metals, primary productivity, biodiversity and climate change.

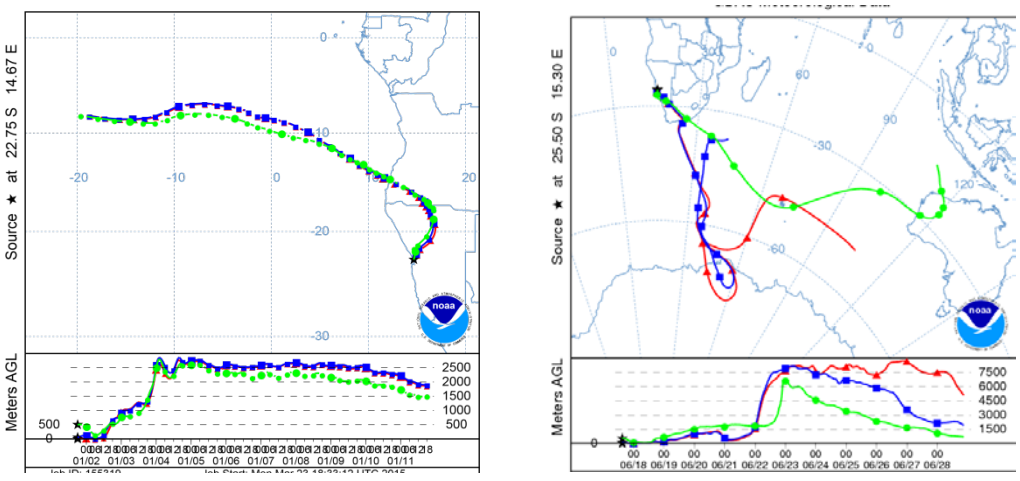
By understanding the mechanistic role of trace metals in primary productivity, South Africa and Africa can make a major impact in helping to understand and predict the evolution of global carbon-climate systems as well as the effects of changes in primary productivity on marine ecosystems.



Trace-clean sampling of Southern Ocean seawater up to a depth of 4 km. The samples are processed in a class-100 clean container laboratory on board South Africa's polar research vessel, SA Agulhas II.

Over the last two years, our research has involved development of sophisticated methods to measure ultra-trace concentrations of metals in seawater, experiments on light and iron limitation on phytoplankton production, determining speciation of particulate iron using synchrotron based techniques and more recently, the transport of atmospheric dust as a source of nutrients for phytoplankton in the Southern Ocean.

Using a multidisciplinary approach, we hope to gain a fundamental understanding of the biogeochemical controls over ocean productivity and associated impact on global change processes. Results from our research will be presented at the 2016 Ocean Sciences meeting in the USA and at the SCAR meeting in Kuala Lumpur in August 2016.



NOAA HYSPLIT: Forward air trajectories models for dust particles as source of nutrients in ocean: 29 Jan 2015 (summer) and 17 Jun 2015 (winter)

Major enhancements to analytical facilities

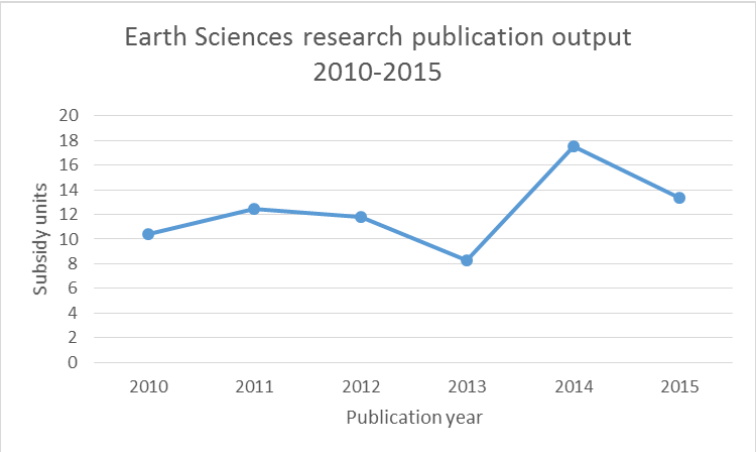
3A pico-Fast® system has been acquired for pre-concentration of sea-water samples for trace elemental analysis using ICP-MS. The system is now installed and validated for measurement of bioactive trace elements.

Major advances have been made to facilitate analyses of trace metals in the environment. The Center for Trace and Experimental Biogeochemistry, headed by Prof. Roychoudhury, has acquired a Pico-Fast system that allows for pre-preparation of ultra-trace (picomolar metal concentration) seawater samples for their accurate measurement using ICP-MS. Prof. Roychoudhury also received a grant from the National Equipment program of NRF which facilitated the purchase of Agilent 7900 quadrupole ICP-MS and Agilent 8800 QQQ ICP-MS, the first of its kind in South Africa. The unique configuration of an additional mass analyser in front of the reaction cell in 8800 QQQ ICP-MS leads to efficient interference removal in even the most challenging of matrices, resulting in an abundant sensitivity superior to any quadrupole ICP-MS as well as improved isotope ratio and radionuclide measurements. Both instruments have now been installed as part of SU's Central Analytical Facilities (CAF).

RESEARCH PROFILE

Research output

The Department is known for its high impact research in the field of Earth Sciences. In 2015 36 articles were published in accredited international journals and in the last five years a number of publications have appeared in high impact journals (impact factor of 8 to 34), including international journals such as *Science* and *Nature*.

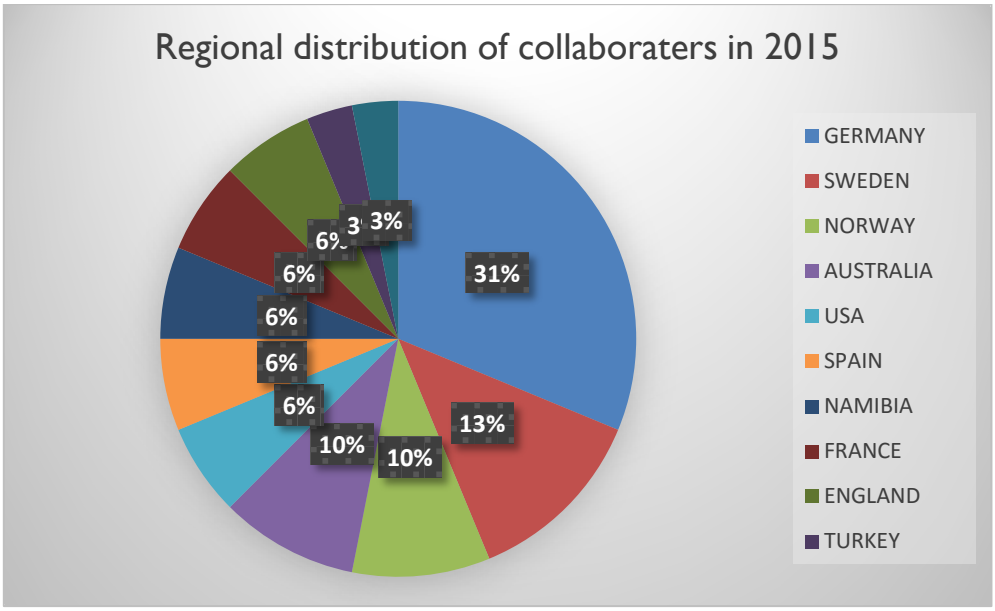


NRF-rated researchers

Internationally acclaimed researcher	Prof. IS Buick	metamorphic petrology, geochronology and isotope geochemistry
	Prof. JD Clemens	granite petrogenesis
	Prof. A Kisters	structural geology
	Prof. G Stevens	experimental petrology
Established researcher	Dr S Fietz	marine biogeochemistry
	Prof. A Roychoudhury	environmental geochemistry and hydrology

Collaboration

During 2015 staff produced 33 research articles, four conference proceedings and one research report and collaborated with researchers from over 30 institutions from 11 countries worldwide.



Focus on the SANCOOP project

The SANCOOP project, a collaboration between South Africa and Norway on climate change, the environment and clean energy, is now in its second year. Dr Susanne Fietz is working with Prof. Atle Bones from the Norwegian University of Science and Technology (NTNU). The project aims to uncover the adaptation strategies of Southern Ocean algae to the recurrent iron deficiency that limits their growth, photosynthesis and thus their consumption of CO_2.

During 2015 NTNU PhD student Alice Mühlroth joined SU postdoctoral researcher Dr. Raïssa Philibert, PhD student Sandi Smart and two interns from Princeton University on the SA Agulhas II's winter cruise. With the support of Dr Ethel Phiri and Dr James Lloyd from SU's Institute for Plant Biotechnology, all samples collected during the 2015 summer and winter cruises are now being analysed.

Other collaborations include:

Prof. Ian Buick

- Collaboration between Prof. Ian Buick and Prof. Cristiano Lana from the Federal University of Ouro Preto (Brazil) through the program "Programa Ciência Sem Fronteiras/Science without Borders" funded by Conselho Nacional de Desenvolvimento Científico e Techologíco (CNPq, Brazil), continued in 2015. The project involves development of new mineral reference materials for high-spatial solution U-Pb geochronology and isotope tracing, and their application to understanding high-temperature processes in the continental crust.

Dr Susanne Fietz

- Working on the South Africa/Norway Research Collaboration Programme (SANCOOP) with Prof. ATle Bones from the Norwegian University of Science and Technology (NTNU)
- Working on the South African National Antarctic Programme (SANAP) with Dr C. Huguet from the Universidad de los Andes, Colombia.
- Research visit by PhD student Alice Mühlroth from the Norwegian University of Science and Technology (NTNU) for a joint winter research cruise on board the research vessel Agulhas II (July-August 2015)
- Research visit to/from Dr. Carme Huguet from Universidad de los Andes, Colombia, for the set-up of organic paleo-proxy analysis at the LC-MS lab at SU's Central Analytical Facility (Nov-Dec 2015)

Dr Jodie Miller

- Collaborative/multidisciplinary research projects and/or significant partnerships with Prof. Torsten Vennemann, Lausanne University (Switzerland), Prof. Benjamin Mapani, University of Namibia, Dr Christie Rowe, McGill University (Canada) and ; Dr Megan Becker (Centre for Minerals Processing, University of Cape Town)

Dr Bjorn von der Heyden

- Research visit and presentation at Rhodes University, hosted by Prof. Hari Tsikos.

Dr Martin Claussen

- In July 2015, MSc-student Wean Welgemoed and myself conducted field work in the Kasai Craton in the Democratic Republic of the Congo in collaboration Prof. Louis Kipata and his MSc-student Philippe Mukonki from the Department of Geology at Lubumbashi University.
- MSc-student Ms Thendo Netshidzivhe visited Lund University (Sweden) in order to learn how to extract baddeleyites (ZrO_2) crystals from six out of 21 mafic rock samples. These crystals are currently being U-Pb dated at SU's Central Analytical Facility

Prof. G Stevens

- Active collaborative research with Dr Katie Smart from the University of the Witwatersrand and Prof. Chris Harris from the University of Cape Town.
- International collaborators are Prof. Cris Lana, University of Ouro Preto, Brazil, and Prof. J-F Money, University of St Etienne, France. The Department has an active joint-degree programme with both institutions, currently involving six PhD students.

Prof. Roychoudhury

- Active collaboration with Prof. S Myneni, Princeton University, and Phoebe Lam, University of California on nanoparticle characterization
- Collaboration with Prof. J Routh, Linköping University, Sweden, on biomarker proxies for determining paleoclimate change.

Dr Dirk Frei

- Collaboration with Dr Russel Bailie from the University of the Western Cape on the geological genesis of the Namaqua-Natal Belt)
- Collaboration with Prof. Sebastian Tappe from the University of Johannesburg on the geochronology of kimberlites in Southern Africa
- Collaboration with Prof. Nicholas Beukes within the multidisciplinary Centre of Excellence "CIMERA"
- Collaboration with Prof. Fanus Viljoen from the University of Johannesburg on the Petrogenesis of Gemstone bearing South African Pegmatites)
- Collaboration with Prof. Judith McKinnaird from the University of the Witwatersrand on the Geochronology of the Northern Lobe of the Bushveld Complex)
- Collaboration with Prof. Steffen Buettner from Rhodes University on the Geochronology of Gemstone bearing pegmatites from Malawi
- International collaboration with Dr. Jeremie Melleton from BRGM, Orleans, France, on the Geochronology of Coloumbite-Tantalite bearing pegmatites in the European Variscan Belt
- International collaboration with Prof. Marina Yudovskaya from the Russian Academy of Sciences on the stratigraphy of the host rocks of the Sukhoi Log gold deposits, Siberia
- International collaboration with Prof. Andrew Whitham from the Cambridge Arctic Shelf Programme, University of Cambridge, on the Stratigraphic correlation of source and reservoir rocks of the Barents Shelf)
- International collaboration with Prof. Andreas Moeller and Prof. Noah McLean from the University of Kansas on the further development of data reduction software for U-Pb-Th age data)
- International collaboration with Prof. Dave Cornell from Gothenburg University on the "Geodynamic evolution of the volcano-sedimentary Sinclair and Koras Groups"

Funding

South Africa

Department of Science and Technology
Geological Society of South Africa (GSSA)
National Research Foundation, South Africa
Namakwa Sands
Stellenbosch Institute For Advanced Study (STIAS)
Stellenbosch University
University of Johannesburg
University of the Witwatersrand
THRIP

International

Universidad Complutense De Madrid
University of Melbourne
U S NSF
Swedish National Research Council
Swedish Museum Of Natural History
Spanish Project Ministerio De Economia Y Competitividad
Society of Geology Applied to Mineral Deposits
Society in Science Branco Weiss Fellowship
Science Foundation, Ireland
Royal Physiographic Society in Lund
Richard Ward Endowment
Research Council, Sweden
Research Council, Norway
Research Council, Denmark
Curtin University, Australia
Newmont Mining Corporation through Society of Economic Geologists (SEG)
MINSACO Resources
Ministerio De Economia Y Competividad Spanish
Minerva Foundation
James Cook University Key Centre
Israel Science Foundation
Institute For Mineralogy And Mineral Resources
Technical University Of Clausthal, Germany
Hugh E Mckinstry Fund through Society of Economic Geologists (SEG)
German Academic Exchange Service DAAD
Geological Survey of Finland
CSIRO
COMRO
Centre National De La Recherche Scientifique France
Australian Research Council
ARC Core to Crust Fluid System Centre of Excellence, Australia
Anglogold Ashanti, Namibia

Awards

MSc student Ms Kelley Swana, supervised by Dr Jodie Miller, received the best poster award at the Applied Isotope Geochemistry Symposium (AIG11) which took place in September 2015 in Orleans, France. Her work focuses on characterisation of deep groundwater in the Main Karoo Basin prior to any shale gas fracking. In 2014 she also received the best early career hydrogeologists network (ECHN) poster award at the International Association of Hydrogeologists' International Convention in Marrakesh, Morocco.

Ms Kelley Swana receiving the best poster award at the Applied Isotope Geochemistry Symposium in France.

Academic activities

Prof. JD Clemens

- Attended the annual Igneous and Metamorphic Studies Group Meeting in Pretoria
- Attended the Goldschmidt Conference in Prague

Dr S Fietz

- Attended a discussion meeting on the biological and climatic impacts of ocean trace element chemistry, organised by The Royal Society in London (UK) from 7 to 8 December 2015.
- Attended a workshop, "Quantifying fluxes and processes in trace-metal cycling at ocean boundaries", hosted by The Royal Society, Buckinghamshire (UK) from 9 to 10 December 2015.
- Co-authored a presentation entitled "Hydroxylation of glycerol dialkyl glycerol tetraethers may enhance membrane fluidity in Archaea adapted to cold environments", which was presented as an invited plenary talk by Xavier Daura (Universitat Autonoma de Barcelona, Spain) at the Workshop on Biomaterials, Salou, Spain, October 2015.
- Co-authored a poster on the "Use of molecular dynamics to assess the biophysiological role of hydroxyl groups in glycerol dialkyl glycerol tetraethers" at the European Geosciences Union General Assembly (EGU), Vienna, presented by Carme Huguet (Universidad de los Andes, Colombia).
- Co-authored a talk on the "Effects of iron and light co-limitation on Southern Ocean phytoplankton. New perspectives in the Polar Sciences" presented by Raissa Philibert (SU) at the APECS International Online Conference, April 2015.
- Co-authored a talk on "The Pliocene Sea Ice Cover in the Arctic Ocean" presented by Jochen Knies (Geological Survey of Norway) at the American Geological Union's Fall Meeting, San Francisco, November 2015.

Dr J Miller

- *Attended the International Atomic Energy Agency (*IAEA) Symposium on Isotope Hydrology, Vienna Austria, May 2015
- Attended the 25th Goldschmidt Meeting, 16 to 21 August 2015, Prague, Czech Republic
- Attended the International Association of Hydrogeologists 42nd Congress, Rome, 13 to 18 September, 2015

Dr B von der Heyden

- Conference presentation at the First African Light Source Conference, Grenoble (France)

Dr M Klausen

- Attended the annual Igneous and Metamorphic Studies Group Meeting in Pretoria
- Attended the 35th Goldschmidt Conference, Prague

Dr D Frei
- Attended the Goldschmidt Conference, Prague, Czech Republic

Prof. G Stevens
- Presented a talk at the Granulite and Granulites conference in Windhoek, Namibia (July 2015). Members of his research group, Kistin Cilliers, Matt Mayne, Nonkuselo Madlakana and Valby Van Schijndel also presented talks.

Service to the scientific community

Prof. JD Clemens
- Igneous and Metamorphic Studies Group, affiliated with the Geological Society of South Africa (president)
- Earth Sciences Ratings Panel for the National Research Foundation (member)

Dr Susanne Fietz
- Serves on the NRF Thuthuka Panel
- Evaluator for NSF (USA) New Generation of Polar Researchers (NGPR) Programme

Dr Jodie Miller
- Chairperson of the Western Cape Branch of the Geological Society of South Africa
- Committee Member, International Association of GeoChemistry
- External examiner for University of Cape Town and Nelson Mandela Metropolitan University

Dr Bjorn von der Heyden
- Member of the African Light Source Steering Committee

Dr Dirk Frei
- Served as Member of NRF review panel for joint DAAD-NRF MSc and PhD fellowship programme

Dr Ryan Tucker
- Outreach: Society of Vertebrate Palaeontology; Auction committee
- Educational Outreach: Mafetang (Lesotho) school district field trip
- Western Cape Branch of the Mountain Club of South Africa (Geo-nature Hikes)

Prof. Alex Kisters
- South African Committee for Stratigraphy – Archaean sequences (member); South African Committee for Stratigraphy – Pan-African sequences (chair)

Prof. Alakendra Roychoudhury
- GEOTRACES programme (South African representative and steering committee member)
- Council for the International Association of GeoChemistry (member)
- Africa Earth Observatory Network (AEON) (founder member)
- Marine Research Institute, University of Cape Town (member)
- Applied Centre for Climate and Earth Systems Science (ACCESS) (steering committee);
- National Oceanographic Equipment and Planning Committee
- External examiner for University of the Free State

Editorial activities

Dr Martin Klausen
- Guest editor for Special Volume 183 in GFF (Scandinavian Journal of Geology)

Dr Dirk Frei
- Served as Associate Editor for the journal Mineralogy and Petrology
- Served as reviewer for the National Research Foundation (NRF), the German Science Foundation (DFG) and the Swiss National Science Foundation (SNF)
- Reviewer for international peer reviewed journals such as Chemical Geology, Contributions to Mineralogy and Petrology, Ore Geology Reviews, Terra Nova, Geostandards and Geoanalytical Research

Dr Ryan Tucker
- Editor of *Frontiers*
- Review Editor for Paleontology, Frontiers in Ecology and Evolution and Earth Science

Prof. Alex Kisters
- On the editorial board of the South African Journal of Geology

Prof. Gary Stevens
- Editorial board of the Journal of Metamorphic Geology

Prof. Alekandra Roychoudhury
- Associate editor of Frontiers in Environmental Sciences: Groundwater Resources and Management
- Review editor for Frontiers in Marine Science: Ocean Observation

Social impact

Dr Ryan Tucker organised a field trip for nearly 200 Grade 1 to 5 learners from schools in the Mafetang district in Lesotho as part of ongoing field work in the region. He also accompanied nine Grade 10 learners from Somerset West on a geo-nature hike, organised by the Western Cape branch of the Mountain Club of South Africa on 7 to 8 April.

Dr Ryan Tucker in action during a field trip for Grade 1 to 5 learners from schools in the Mafetang district, Lesotho.

ACADEMIC AFFAIRS

Teaching and learning

This year we had an honours cohort of 27 students, which is impressive in the context of our small staff complement. Feedback from external examiners suggests that we have the highest-quality honours students of any earth sciences or geology department in the country. We had 28 MSc and 12 PhD students registered in the Department, as well as two postdoctoral fellows.

Despite the large undergraduate classes, the Department strives to provide hands-on teaching in a highly applied field. To ensure the practical competencies of our students, an unusually large number of contact hours were allocated to field skills (288 hours from first year to honours), of which the

honours students' annual mines tour is one of the highlights. Our students benefit from learning in a collegial environment from our cohort of highly competitive and diverse staff.

Honours tour 2015

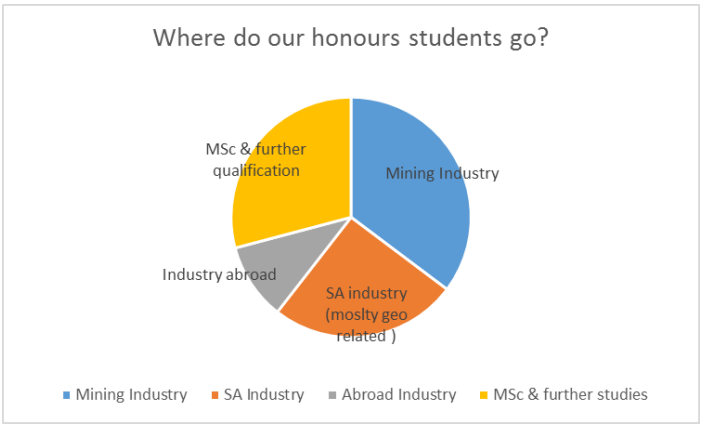
The annual two-week-long honours tour took 27 students to six active mines across the Western and Northern Cape, southernmost Namibia and the Northwest Province (see map). Along the route particular attention was paid to the geology (1) of Bushmanland's terminated Okiep copper mining district (including active dimension stone quarrying), (2) along Orange River's spectacular Karoo-Nama-Richterveld transect, (3) within the Augrabies Falls National Park, (4) of both a proposed Archaean (Setlagole) and the oldest verified (Vredefort) impact craters, and, finally, (5) of many aspects of the Karoo Supergroup exposed along the three day long return drive from the Golden Gate National Park, along the border of Lesotho and down to the Zebra Mountain National Park. The students acquired insight into working at a mine (Tau Lekoa's underground visit made a deep impression) and experienced much of South Africa's geology and stratigraphy that they had previously only learned about in theory. In earth sciences, this connection between lecture room knowledge and practical experience is especially vital.

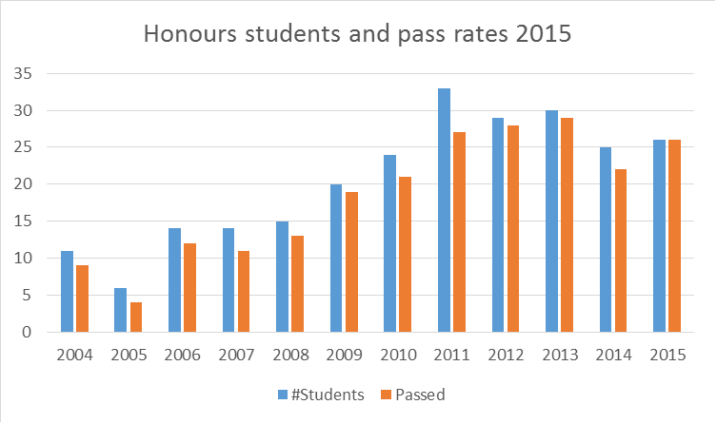
Honours students from the Department of Earth Sciences on excursion in the underground mine Tau Lekoa, Klerksdorp Gold Field, and visiting the Vredefort dome.

Focus on postgraduate students

The undergraduate programme is aligned with the Department's mission: "To serve South African society by producing graduates equipped with the high-level skills needed to take our minerals and energy industry forward, in terms of exploration, mining, minerals processing, and environmental monitoring, design and remediation".

Honours graduates are trained for direct entry into the mining industry (see pie chart below):





Staff matters

Prof. Abraham Rozendaal served a venerable term at SU and retired at the end of 2014. For the interim, Prof. Franz Michael Meyer (head of the Department of Mineralogy and Economic Geology, RWTH Aachen University) was appointed as a guest lecturer.

Dr Bjorn von der Heyden is the new economic geology lecturer. As a student here, he won the Geological Society of South Africa's Haughton Award for the top geology Honours thesis in South Africa. Most of his PhD research on iron nano-particle mineralogy were conducted at Princeton University in the USA. An article based on PhD was published in the prestigious journal *Science*. He worked for two years at Exxaro Resources, contributing to their operations at Arnot and Grootegeluk coal mines, the Mayoko iron ore project and their Research and Development (mineralogy) unit. He will begin his lecturing duties in 2016.

In October 2015 Dr Martina Frei joined the administrative team with the responsibilities of the geochemical laboratory, postgraduate administration and practical support in teaching.

Staff list

Academic

Prof. IS Buick
Prof. JD Clemens
Dr S Fietz
Dr R Heyn
Prof. A Kisters
Dr M Klausen
Dr J Miller
Prof. A Roychoudhury
Prof. G Stevens
Dr R Tucker
Dr B von der Heyden

Extraordinary professors

Dr I Basson
Prof. D Frei
Prof. A Gerdes
Dr N Phillips

New appointments

Dr B von der Heyden

Support staff

Ms L Conradie
Ms M Frei
G Olivier
F Timney

Retired

Prof. A Rozendaal

DEPARTMENT OF MATHEMATICAL SCIENCES

(Mathematics, Applied Mathematics, Computer Science)

Together the divisions of Mathematics, Applied Mathematics and Computer Science forms the Department of Mathematical Sciences at Stellenbosch University.

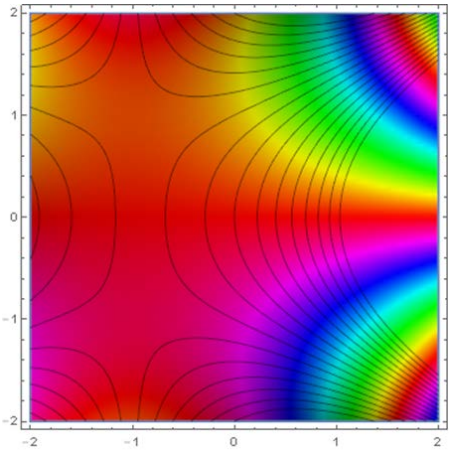
RESEARCH INTERESTS

Mathematics	Applied Mathematics	Computer Science
•Algebra & number theory •Analysis & topology •Foundations of mathematics •Discrete mathematics •Mathematics & computational biology	•Computer vision, pattern recognition, machine learning •Fluid dynamics & modelling •Numerical analysis & scientific computing •Applied Discrete Mathematics	•Program verification •Software engineering •Machine learning & computer vision •IP networks •Automata theory & formal languages

RESEARCH HIGHLIGHTS

New research in mathematics

Dr Gareth Boxall co-authored a paper entitled "Rational values of entire functions of finite order" with Prof. Gareth Jones from the University of Manchester. It was published in the prestigious *International Mathematics Research Notices*. In this article, they prove that there are, in some sense, few rational points on the graphs of certain functions. Specifically, they are interested in functions f from the field of complex numbers to itself that are assumed to be differentiable (entire) and grow neither too quickly nor too slowly (there is a formal technical condition to make this precise).



Visualisation of an entire function of finite order, as studied in Dr Boxall's paper.

From these assumptions they conclude that there are, in some sense, few rational numbers z for which *f(z)* is also rational. This notion of "few" must be defined carefully. It does not, for example, exclude the possibility that there are infinitely many such z. Every rational number has what is called a height. This is defined to equal the maximum of the sizes of its numerator and denominator when written as a fraction in simplest

terms. For a function *f* as above, they prove that, for any *r>0*, there exist constants $C,\gamma > 0$ such that, for each *H>3*, there are at most $C(\log(H))^{\gamma}$ rational z of size at most r with the property that both z and *f(z)* have height at most *H*.

For many of the functions to which this applies, one expects there to be no rational points at all, or at least only a few exceptional ones. The results obtained by Dr Boxall and his co-author can therefore be seen as an important step towards verifying that. Similar results have applications in Diophantine geometry, which is another motivation for work in this area.

FOCUS ON: SARChI chair in Mathematical and Theoretical Physical Biosciences

Prof. Cang Hui

During 2015 Prof. Hui published 19 articles with colleagues and students in peer-reviewed journals, two book chapters, as well as two R software packages. They also delivered 16 conference presentations, four in SA and the rest overseas (Australia, Brazil, Germany, Sweden, UK, USA). During 2015 three Honours, four MSc and one PhD student graduated.

In February 2015, Prof. Hui co-chaired a workshop, held by the German Centre of Integrative Biodiversity Research (iDiv) in Leipzig (Germany) on monitoring and reporting on biological invasions. The workshop was funded by the Groups of Earth Observations Biodiversity Observation Network (GEO BON). In September, he participated in a small workshop on potential regime shifts from biological invasions, held by the National Socio-Environmental Synthesis Center of the USA in Maryland. In November, colleagues and he delivered four related presentations in the Annual Meeting of Ecological Society of Australia in Adelaide on measuring species turnover by zeta diversity. In December, he delivered a plenary on building a unified theory in community ecology at the EcoStats Meeting held by the University of New South Wales in Sydney.

Two of Prof. Hui's publications were published in the leading journal *Proceedings of the Royal Society B* (Biological Sciences). Of these two, one is on proposing the Community Assembly Phase Space (CAPS), a multidimensional space that uses community processes to reveal hidden complexity in neutral-niche community dynamics, while the other incorporates a hybrid behavioural rule of adaptive interaction switching and random drift into a bipartite network model to explain network emergence.

Another two articles were published by the *Nature* group journal, *Scientific Reports*. The one article identifies possible reasons for the disparity between the population dynamics of cereal aphids and armyworms under global change, while the other identifies the relative importance of nitrogen input and cropland expansion on cereal aphids and their natural enemies. Some other interesting work include the discovery of a clear pattern of shifting nestedness in the diversity of litter-consuming detriivorous invertebrates in streams along the latitudinal gradient, using a global dataset along the latitudinal gradient, published in *Ecography*.

Postdoctoral fellows:

Dr Andriamihaja Ramanantoanina (Madagascar)

- Mihaja (PhD from SU, 2014) focuses on modelling eco-evolutionary dynamics using PDEs. She is currently investigating the evolutionary games of species interactions, with an emphasis on the emergence and maintenance of mutualistic interactions.

Dr Pietro Landi (Italy)

- Pietro (PhD *cum laude* in Information Engineering, Polytechnic of Milan, 2014). He is working on the evolution of self-fertilisation and dispersal of timing of switch points in complex life histories, and of fish stocks' maturation schedule under dynamic and adaptive fishing.

Dr James Rodger (South Africa)

- James (PhD from UKZN and now postdoctoral fellow at Uppsala University, Sweden. In 2015, he collaborated with fellow postdoc Dr Pietro Landi on a model of the joint evolution of self-fertilisation and dispersal. He also compiled a dataset on the relationship between pollination success and plant abundance for the purposes of meta-analysis.

Dr Henintsoa Onivola Minoarivelo (Madagascar)

- Ony (PhD in Mathematics, SU) has just been awarded a Centre of Excellence-MASS fellowship to conduct postdoctoral research on the robustness of mutualistic interaction in the face of environmental perturbations.

Dr John B. H. Njagarah (Uganda)

- John (PhD Mathematics, SU) focused on spatiotemporal infectious disease transmission dynamics using systems of PDEs. In 2015, he started to work on the spatial spread and pattern formation in epidemiological models.

Dr Beverley Grieshaber (South Africa)

- Beverley (PhD Mathematics, UCT) is working on extending the implementation of a standard Dynamic Energy Budget (DEB) model to include intergenerational variation. In particular, she focussed on incorporating the ability to diapauses in specialised DEB model for insects.

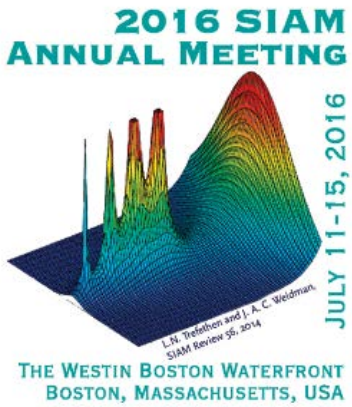
Dr Chris Broeckhoven (Belgium)

- Chris (PhD Zoology, SU) developed a protocol to obtain high resolution micro-CT images of live lizards. He is now working on explaining and modelling the development, function and evolution of body armour in girdled lizards.

Applied mathematics

Prof. André Weideman was a plenary speaker at the "New Directions in Numerical Computation" conference, held in celebration of Prof. Nick Trefethen's 60th birthday from 25 to 28 August 2015. Prof. Trefethen is a University of Oxford Global Distinguished Professor and head of Oxford's numerical analysis group. The conference took place in the new Andrew Wiles Building, which houses the Mathematical Institute of Oxford University. The title of Prof. Weideman's talk was "The Shortest Path: Complex Detours in Real Computation". A figure from the 2014 paper he co-authored with Prof. Trefethen in *SIAM Review* got selected as the logo for the 2016 Annual Meeting of the Society for Industrial and Applied Mathematics (SIAM).

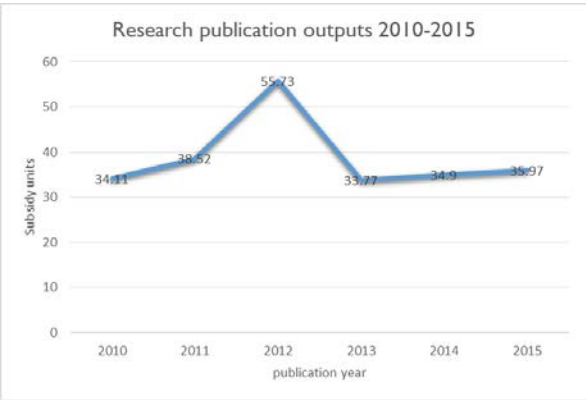
Prof. Andre Weideman

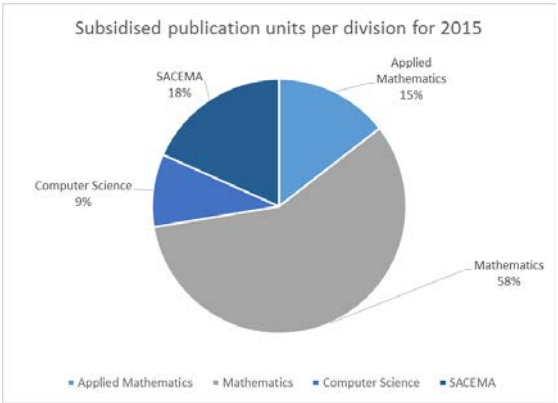


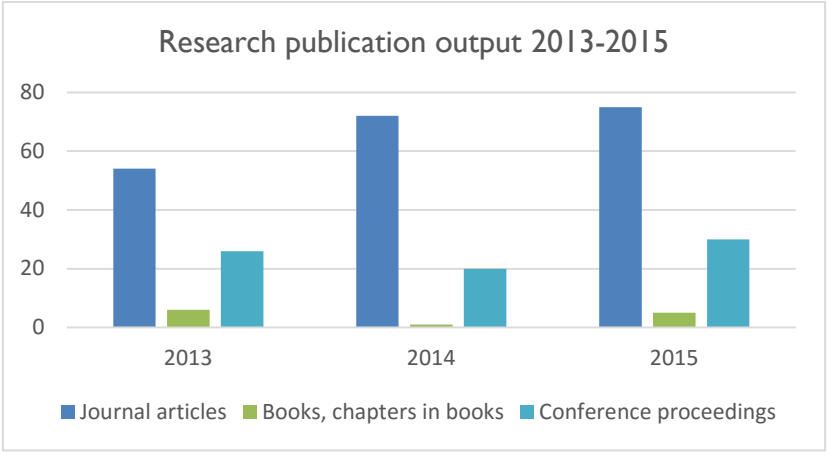
RESEARCH PROFILE

Research output

During 2015 researchers co-authored 70 publications (research articles, book chapters and conference proceedings) with academics from over a hundred institutions in nine different countries. After an exceptional peak in terms of research outputs in 2012, the Department has again seen a steady increase in the number of subsidised publication units since 2013.





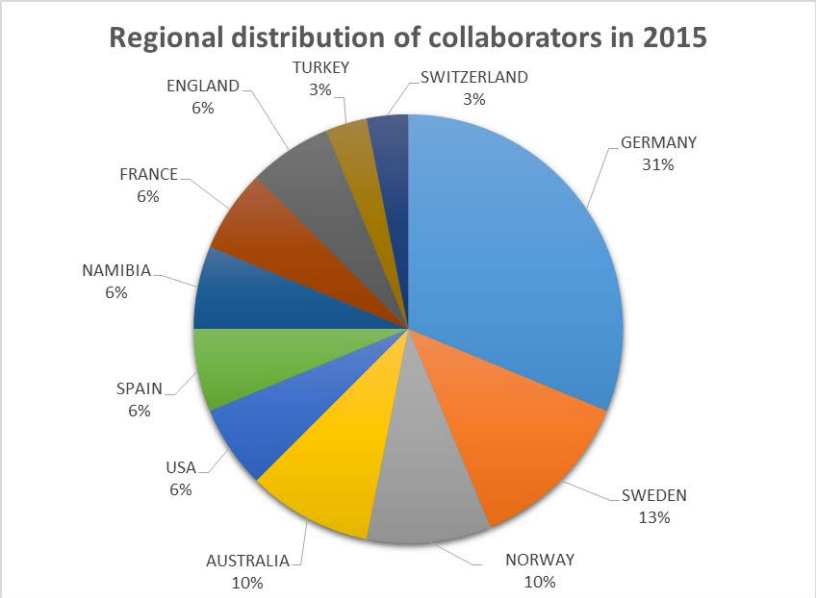


NRF-rated researchers

Leading international researcher	Prof. Helmut Prodinger	analysis of algorithms, number theory and combinatorics
Internationally acclaimed researcher	Prof. Ben Herbst	computer vision and machine learning
	Prof. Leon van Wyk	ring theory and matrix algebras
	Prof. Stephan Wagner	Graph theory and combinatorics
	Prof. Willem Visser	software failure, software engineering and software development
Established researcher	Prof. MK Banda	numeral methods for vlow and transport processes
	Prof. Florian Breuer	number theory
	Prof. Bernd Fischer	software engineering
	Dr Jaco Geldenhuys	software engineering, specifically model checking and process algebra
	Prof. Sonja Mouton	banach algebras and spectral theory
	Dr Farai Nyabadza	mathematical biology
	Prof. Ingrid Rewitzky	mathematics of computer science
	Prof. Brink van der Merwe	automata theory
	Prof. Lynette van Zijl	theoretical computer science and asisstive technologies
Young upcoming researcher	Dr Cang Hui	mathematical and theoretical physical biosciences

Collaboration

Based on publication outputs for 2015, the Department has most often co-authored publications with researchers from the USA (35%), followed by China (15%), Austria (12%) and Italy (10%) (see pie-chart below).



Collaboration with the African Institute of Mathematical Sciences

Stellenbosch University and particularly the Department of Mathematical Sciences have been collaborating with AIMS ever since its establishment in 2003. AIMS has become an important source of excellent postgraduate students, and the Honours programme in Biomathematics is offered jointly with AIMS.

Staff actively participates in the AIMS Structured Masters programme by offering courses. Dr Karin-Therese Howell offered Algebra, Dr Gareth Boxall Model Theory, while Dr Dimbinaina Ralaivaosaona and Prof. Stephan Wagner offered Mathematical Problem Solving. Moreover, a dozen essay projects were supervised by members of the Department of Mathematical Sciences, the Department of Physics and SACEMA. AIMS researchers are also actively involved in our postgraduate programme by supervising or co-supervising MSc- and PhD students.

International collaborations: Applied Mathematics

Prof. André Weideman wrote a joint paper with Prof. Bengt Fornberg, University of Colorado at Boulder, Colorado, USA, and another joint paper with Prof. Benedict Dingfelder, Technical University of Munich, Germany.

The MSc students from SU having lunch in Trento

Prof. Ben Herbst was the South African project leader for Quostream, an international three-year long project funded by the European Union Marie Curie Framework 7 programme. This was a collaborative effort between the universities of Stellenbosch, Novi Sad (Serbia), Trento (Italy) and Glasgow (Scotland), among others. During 2015, a number of exchange visits took place, including a two month visit to the University of Trento by six MSc students from SU.

A five-year Erasmus Mundus agreement with University of Trento, Italy, will allow for the exchange of faculty and students between the two universities. A three-year agreemeent with the Joint Insitute for Nuclear Research, Dubna, Russia, was entered to foster joint research between SU and the JINR.

Prof. GJF Smit visited the University of Bergen, Norway, from 14 to 22 January 2015 to work on a research project with Prof. P. Kosinski and former student Dr Marèt Cloete who is currently a postdoctoral fellow at the same university.

Dr GPJ Diedericks gave support to the aquaculture service company Havbrukstjenesten in Norway to develop routines in extreme value analysis (EVA) to calculate the return periods of waves and currents.

Dr Sonia Woudberg-Fidder visited the University of Groningnen in the Netherlands from 23 November to 23 December 2015 as part of an European Saturn Erasmus Mundus Scholarship for staff mobility.

International collaboration: Discrete Mathematics

The Discrete Mathematics group in the Mathematics Division has a strong partnership with the research group headed by Prof. Clemens Heuberger at the Alpen-Adria-Universität Klagenfurt in Austria. This fruitful collaboration has already led to some 20 journal publications.

Prof. Heuberger has been visiting the division every year since 2005, and several other members of his team have been to Stellenbosch. Conversely, Prof. Helmut Prodinger visited Klagenfurt several times, and Prof. Stephan Wagner spent three months of his research leave in 2015 as Karl Popper Fellow in Klagenfurt where he worked with Prof. Heuberger and his team.

International collaboration: Computer Science

During 2015 the Computer Science Division hosted a number of international visitors. They were, inter alia, Prof. Mark van der Brand from the Technische Universiteit Eindhoven in the Netherlands (26 January to 3 February 2015); Prof. Ina Schiering from TU Braunschweig, Germany (1 October); Prof. Sergei Obiedkov and Prof. Dimitry Ilvovsky from the Higher School of Economy, Moscow, Russia (November 2015); Prof. Stefan Jaehnichen from TU Berlin (January and November 2015); Dr Hellis Tamm, Cybernetics Institute, Tallinn (Estonia) for joint visits in June and November 2015.

As part of a bilateral agreement, Prof. Jaco Geldenhuys conducted a research visit to KAIST, South Korea, in September 2015. Several of our researchers made international research visits to, inter alia, Prof. Mark van den Brand, Eindhoven University of Technology, Netherlands; Dr Gennaro Parlato, University of Southampton, UK (20-23 April); Dr Mirco Carbone, IMT Lucca, Italy (19-20 May); Prof. Myra Cohen, UNL Lincoln, USA; and to Prof. Marcelo Frias, University of Buenos Aires, Argentinia (14-17 December). Other collaborative projects are with:

- Dr Gennaro Parlato (University of Southampton, United Kingdom) and Prof. Salvatore La Torre, University of Salerno, Italy. Project: Sequentialization of concurrent programs
- Prof. Lucas Cordeiro, Federal University of Amazonas, Manaus, Brazil. Project: Bounded Model Checking
- Prof. Sergei Obiedkov, Higher School of Economy, Moscow, Russia. Project: Concept Analysis
- Dr Hellis Tamm, Cybernetics Institute, Tallinn, Estonia: Project: Involved in a SA-Sweden bilateral NRF call submission

Funding

South Africa

African Institute for Mathematical Sciences (AIMS)
Department of Defence
Department of Environmental Affairs through South African National Biodiversity Institute's Invasive Species Programme
Department of Science and Technology
DST/NRF Centre of Excellence for Invasion Biology
Engineering and Physical Sciences Research Council
National Institute of Theoretical Physics
National Research Foundation
National Research Service Award National Eye Institute
South African Research Chairs Initiative Of The Department Of Science And Technology
Special Fund For Public Welfare Projects Forestry
Square Kilometer Array Project In South Africa
Oppenheimer Memorial Trust
Stellenbosch University
University of the Free State
University of the Western Cape
Working For Water Programme

International

Academy of Finland
AMFAR Grant
Australian Research Council
Austrian Ministry of Science and Research
Austrian Science Fund
Bioinformatics and Information Technologies Core
Chinese Academy of Sciences
China Postdoctoral Science Foundation
Department of Veterans Affairs
DFG Collaborative Research Centre
European Science Foundation
European Social Fund
European Union
Evolution and Ecology Program EEP IIASA
FAIR
FSE Regione Lombardia
Fundamental Research Funds for the Central Universities
German Academic Exchange Service
Graduate Program Topmath of the Elite Network of Bavaria
International Aids Vaccine Initiative
International Institute for Applied Systems Analysis
HASA Austria
Italian Ministry for University and Research
James B Pendleton Charitable Trust
Knowledge Innovation Project of CAS
Maryland Center for Fundamental Physics
MINECO S Project
Ministry of Education Universities and Research under the Project Fire Futuro in Ricerca Modeling and Analysis of Innovation and Competition Processes
Monash University
Australian Research Council
Nanjing Forestry University
National Geographic Society Committee for Research and Exploration
National High Technology Research and Development Program of China
National Institutes of Health
National Key Technology RD Program
National Natural Science Foundation, China
National Science Centre, Poland
NPRP from Qatar National Research Fund
NSF Science and Technology Center for Science of Information
OTKA of Hungary
Jiangsu Higher Education Institutions
Royal Society
Sixth Framework Program of the European Commission
Strategic Priority Research Program of the Chinese Academy Of Sciences
European Community Research Infrastructure Action, FP7 Integrating Activities Programme
Technische Universitat Munchen, Germany
UC Laboratory Fees Research Program
UCSD Center For Aids Research
Université Paris 13 Sorbonne Paris, France
University of California, USA
Vienna Science and Technology Fund

Awards

Rubbi Book Prizes for the mathematics students in 2015 were awarded in the following categories:

- **First year mathematics:** Sarah Selkirk (BSc Mathematics) with 99.5% and Willem Ackermann (BCom Actuarial Science) with 98%
- **First year engineering mathematics:** Günther Hüsselmann (Beng Industrial Engineering) with 99.5% and René Spoerer (Beng Electrical Engineering) with 99.5%
- **Second year mathematics:** Gerben Draaijer (Bcom Actuarial Science) with 94% and Peter Thompson (BSc Mathematics) with 88%
- **Third year mathematics:** Gerhardus Kirsten (BSc Mathematics) with 70.5% and Nathan Pillay (BSc Mathematics) with 65.5%
- **Honours:** Michael Hoefnagel (BSc Hons Mathematics) with 83% and Julia Rozanova (BSc Hons Mathematics) with 81%

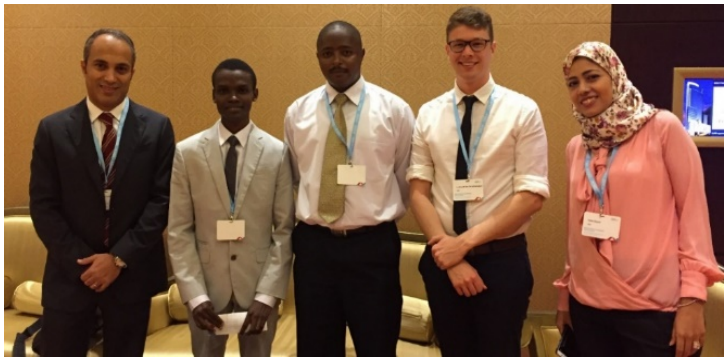
Maties maths students under top 20

Four mathematics and engineering students ended in the top 20 of the 250 tertiary students who participated in the annual South African Tertiary Mathematics Olympiad held in August.

From the left, Petro-John Last, Dr Dirk Basson and Sarah Selkirk.

Petri-Johan Last, a third year engineering student, came second overall, while Sarah Selkirk, a first-year mathematics student, came fifth. The students had two hours to solve 20 problems. The winner, a student from Cape Town University, scored 13 out of 20. Petri-Johan's score was 11 out of 20. Most of the 250 students who participated could only solve two to three problems.

The **Computer Science students** also performed well. Final year student Lodewyk van der Westhuizen was one of three winners in the IBM Master the Mainframe competition for students in the Middle East and Africa. He won a smart phone to the value of R7 000 and an all-expenses-paid trip to IBM's offices in Dubai. This is the first time that IBM hosts the competition in this part of the world.



SU computer science student Lodewyk van der Westhuizen (second from the right) in Dubai.

Robert Sandell, George Phillips and Delena Malan earned second place in Discovery SA's Gradhack from 26 to 29 July 2015. Six teams signed up for the ACM ICPC Sub-Saharan Africa Regionals, with our top team coming second. Four teams attended the Standard Bank IT Challenge Heats, with the top team qualifying and attending the finals in Johannesburg. Students also signed up for the CHPC Student Cluster Competition and the SA Innovation Summit Hackathon.

Academic activities

Prof. Zurab Janelidze and Prof. Ingrid Rewitzky from the Division: Mathematics organised the second Workshop on Mathematical Structures in November 2015. There were thirty participants from five different universities in South Africa. The theme of this particular workshop was "Categories in Algebra and Topology", and the workshop featured lecture series on "Protomodular and Mal'tsev Categories" by Dominique Bourn from Laboratoire de Mathématiques Pures et Appliquées Joseph Liouville, Université du Littoral, Calais (France). This workshop was organised as part of the activities of the Centre for Mathematical Structures, which also include a fortnightly seminar on mathematical structures organized by Prof. Rewitzky.

The Annual Congress of the South African Mathematical Society was again attended by several staff members: Dr Gareth Boxall, Dr Retha Heymann, Prof. Zurab Janelidze, Dr Sonja Mouton, Prof. Stephan Wagner, as well as graduate students Liam Baker, Ronalda Benjamin, Taboka Chalebgwa, Kenneth Dadedzi, Jacques Masuret, Francois van Niekerk. They also presented talks.

Other academic activities include:

MATHEMATICS

Dr Dirk Basson
- presented a talk at the AIMS-Stellenbosch University Number Theory Conference

Ms Ronalda Benjamin, Dr Retha Heymann and Prof. Sonja Mouton
- attended the NWU-PUK Mathematics Workshop: Functional Analysis and its Applications and presented talks

Dr Gareth Boxall
- Gave talks at the Stellenbosch/AIMS number theory conference in January, the Stellenbosch model theory conference in March and the model theory special session of the European Logic Colloquium in Helsinki in August

Prof. Florian Breuer
- Gave a talk ``On Abhyankar's Generalized Iteration Conjecture'', at the AIMS-Stellenbosch University Number Theory Conference, January 2015)
- Invited talk on "Analytic Drinfeld modular forms in higher rank" at the Workshop on Function Fields, Zeta Functions and Drinfeld Modular Forms at Imperial College, London, June 2015
- Attended the 29th Journées Arithmétiques in Debrecen (Hungary) in July 2015

Dr James Gray and Prof. Zurab Janelidze
- Invited speakers at the Workshop on Categorical Algebra CatAlg 2015 in Gargnano, Italy

Prof. Farai Nyabadza
- Attended the SAMSA conference in Windhoek (Namibia), from 23-27 November 2015
- Attended the second Kenyatta International conference, 16-19 June 2015
- Attended the AMUCWMA - AWMA workshop, in Naivasha, Kenya, 16-18 July 2015
- Invited speaker at the second Joint UNISA-UP Workshop on Theoretical and Mathematical Epidemiology, 2 - 7 March 2015

Dr Dimbinaina Ralaivaosaona
- Attended the VIII Latin-American Algorithms, Graphs and Optimization Symposium (LAGOS 2015) in Praia das Fontes (Brazil), 11-15 May 2015 and contributed a paper entitled "On the average path length of a cycle plus random edges"

Prof. Leon van Wyk
- Plenary speaker at the SAMSA conference in Windhoek (Namibia), 23-27 November 2015 with a talk "A Cayley-Hamilton trace identity for 2 x 2 matrices over Lie-solvable rings"

Prof. Stephan Wagner
- Attended the ANALCO/ALENEX/SODA conference in San Diego (USA)
- Invited speaker at the Random Walks on Graphs and Potential Theory Conference at Warwick University (UK)
- Attended the 26th International Meeting on Probabilistic, Combinatorial and Asymptotic Methods for the Analysis of Algorithms (AofA'15) in Strobl, Austria
- Attended the 8th Slovenian International Conference on Graph Theory in Kranjska Gora, Slovenia
- Attended the Summer School on Algorithmic and Enumerative Combinatorics in Hagenberg, Austria
- Attended the Joint Austrian-Hungarian Mathematical Conference in Győr, Hungary

Service to the scientific community:

MATHEMATICS

Dr Dirk Basson
- Academic coordinator of the training programme for the team that represents South Africa in the International Mathematical Olympiad (IMO). He also accompanied the team as team leader to the 2015 IMO in Thailand

Prof. Florian Breuer
- Organised (jointly with Barry Green and Peter Sarnak) the AIMS-Stellenbosch University Number Theory Conference, 19-23 January 2015
- External examiner of an Honours course at the University of Cape Town
- External supervisor of an ongoing PhD project at the University of Antananarivo

Dr Gareth Boxall
- Organised (jointly with Charlotte Kestner) a conference on model theory at Stellenbosch in March 2015
- Member of the Association for Symbolic Logic's Committee for Logic in Africa

Prof. Andrew Fransman
- External co-supervisor for the MSc thesis of MJ Lenna, University of Johannesburg
- External examiner of third year and Honours courses at the University of the Western Cape
- Extermal examiner of a PhD thesis (UWC) and an MSc thesis (UNISA)

Dr Karin-Therese Howell
- Examined an MSc project for the University of the Free State

Prof. Farai Nyabadza
- External PhD supervisor of two students from Zimbabwe: Ms Sarudzai Showa, National University of Science and Technology, and Mr Josiah Mushanyu, University of Zimbabwe
- External examiner of six MSc- and PhD theses at UKZN, UWC, University of Venda, University of Botswana and Makerere University (Uganda)

Dr Dimbinaina Ralaivaosaona
- External examiner of an MSc thesis at the University of the Witwatersrand

Prof. Leon van Wyk
- Elected Vice-President of the South African Mathematical Society
- External examiner for Algebra courses at the University of Johannesburg

Dr Dirk Basson and Prof. Stephan Wagner
- Served on the Problem Committee of the South African Mathematical Olympiad. Prof. Wagner is also a member of the Management Committee

Prof. Ingrid Rewitzky
- Serves on the Executive Committee of AIMS-SA
- External examiner for the PhD thesis of Claudette Robinson, University of Johannesburg

APPLIED MATHEMATICS

Prof. JAC Weideman, Prof. BM Herbst and Dr Nick Hale
- Serve on the organising committee of the 40th Annual South African Symposium of Numeral and Applied Mathematics (SANUM) that will take place at SU from 22 to 24 March 2016

Prof. GFJ Smit
- Consulted for Rheinmetall Denel Munition, Denel Dynamics, Formo Fibreglass
- Consulted for the South African Police in the reconstruction of accident scenes
- Acts as consultant with Dr Hardus Deidericks (as project manager), for the numerical modelling to inform a marine ecologist to assess the impacts of the dredged material in the mari-culture activities in the Carlingford louch, Ireland.
- Offers Cambridge A-level mechanics after hours for learners of Paarl Valley High School

Prof. Jac Weideman
- Invited to attend Modern Applications of Complex Variables (Modelling, Theory and Computation): January 2015, Banff International Research Station, Canada. This conference was by invitation only

COMPUTER SCIENCE

Prof. Bernd Fischer
- External PhD supervision of several students from the University of Southhampton: Jeremy Morse (graduated April 2015); Tristan Aubrey-Jones (graduated April 2015); Meng Tian and Geoffrey Birch
- Served as external PhD examiner for Nicolas Rosner from the University of Buenos Aires, Argentinia
- Serving as general chair for the 15th International Conference on Generative Programming: Concepts and Experience (GPCE) in 2016

Dr Jaco Geldenhuys and Prof. Bernd Fischer
- Organised the 22nd International SPIN Symposium on Model Checking of Software

Prof. Lynette van Zijl
- Serves as a member of the Human Language Technology panel
- External examiner for MSc student (UNISA)

Editorial activities

MATHEMATICS

Prof. Florian Breuer
Editor, *Journal of Number Theory*

Prof. Farai Nyabadza
Guest editor of a special issue of the BioMed Research International Journal entitled "Computational and Theoretical Analysis of Human Diseases Associated with Infectious Pathogens"

Prof. Helmut Prodinger
Serves on the editorial boards of six journals: *International Journal of Intelligent Computing and Cybernetics*, Quaestiones Mathematicae, Theoretical Computer Science, the Pioneer Journal of Advances in Applied Mathematics, Turkish Journal of Mathematics, Universal Computer Science

Prof. Ingrid Rewitzky
Associate editor, *Quaestiones Mathematicae*

Prof. Stephan Wagner
editorial board of *Afrika Matematika* and *MATCH Communications in Mathematical and in Computer Chemistry*

COMPUTER SCIENCE

Prof. Bernd Fischer
Editorial board, *Science of Computer Programming* - Software Section (2015-)
Editorial board, *Journal of Universal Computer Science*

SOCIAL IMPACT

24th Stellenbosch Mathematics Camp

The 24th edition of the Stellenbosch Mathematics Camp saw 62 of the brightest young minds from all over South Africa come to Stellenbosch in December for a densely-packed week of mathematics.

The "Intermediate" group of learners attending the Stellenbosch Camp.

This camp is the largest and longest-running of a series of camps sponsored by the South African Mathematics Foundation and forms an integral part of the training and selection process for the teams that represent South Africa in international mathematical competitions, namely the International Mathematical Olympiad (IMO) and the Pan-African Mathematics Olympiad (PAMO). The camp was organised by Prof. Stephan Wagner, and Dr Dirk Basson was responsible for the academic programme. MSc student Liam Baker was one of the coaches who gave lectures at the camp.

Mathematical Olympiad classes

Throughout the year, the Mathematics Division offers biweekly classes to interested and talented high school learners from Stellenbosch region. The aim of these classes, coordinated by Dr Dirk Basson, is to introduce the learners to interesting and clever mathematical ideas and techniques that are not taught at high school, to improve their problem solving skills, and to nurture their passion for the subject. On average, about 20 learners attended the classes.

The training programme also prepares them for competitions such as the South African Mathematics Olympiad (SAMO) and the South African Mathematics Team Competition (SAMTC). The Boland teams participating in the SAMTC are also trained through this programme, and they did very well in the 2015 edition: the three junior teams came 4th, 7th and 11th (among 56 teams) respectively, the senior teams 3rd, 10th and 11th (among 57 teams) respectively.

ACADEMIC AFFAIRS

Teaching and learning: Mathematics

A new module, Foundations of Abstract Mathematics I and II, founded by Prof. Zurab Janelidze and Prof. Ingrid Rewitzky in 2011, has been attracting the interest of students who are passionate about mathematics, including those who major in mathematics and those who do not.

These are year modules, offered in the second and third years, respectively, and run in the evenings to accommodate students across several faculties. The modules are exam-free and follow a flexible assessment system, where marks from various assessment opportunities throughout the year are at

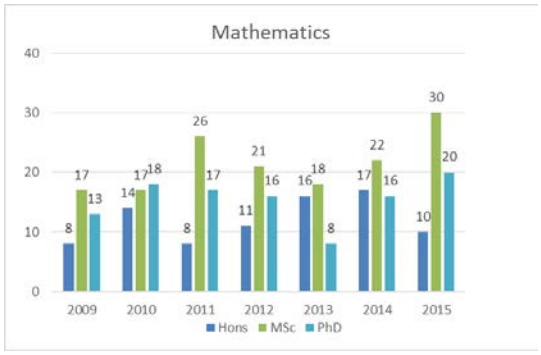
the end added up to a give a final mark, with the total available marks usually one and a half the amount of maximum full mark. Typically, the modules consist of four seminars, each running in a single term and given by a member of the Mathematics Division. There is also an opportunity to do a project under the supervision of a member of the division, which is the default option for the third year module.

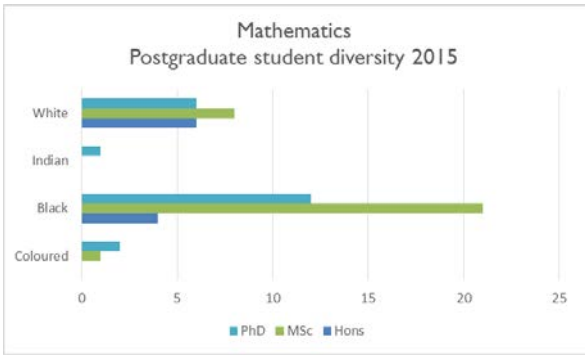
Teaching and learning: Applied Mathematics

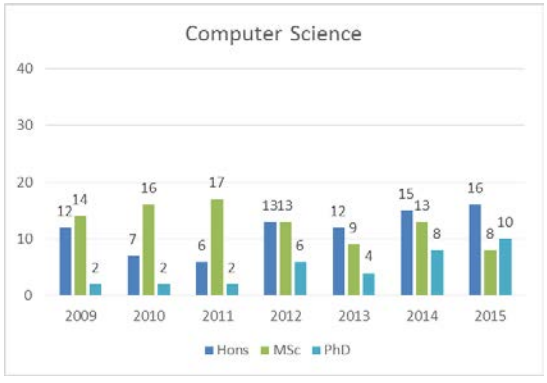
Prof. JAC Weideman and Dr Nick Hale experimented with blended learning in undergraduate engineering and science modules in numerical methods (NM262 and TW324). Dr Sonia Woudberg-Fidder presented a talk on how to uplift spirits and enhance productivity during a Friday afternoon tutorial at the 8th Annual Conference on the Scholarship of Teaching and Learning, Spier, Stellenbosch, 27-28 October 2015. Dr Willie Brink, Dr Paul Grobler and Mr Piet Crous were nominated by their first year students as the lecturers that had the biggest impact on their success.

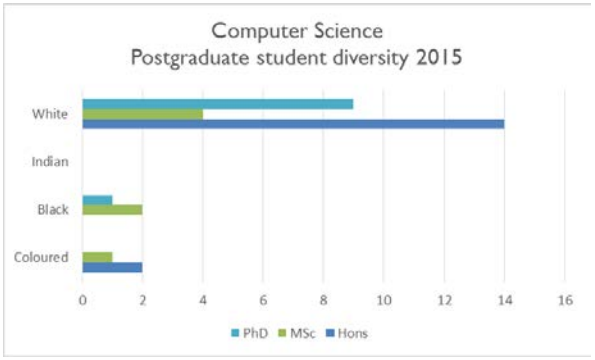
Focus on postgraduate students

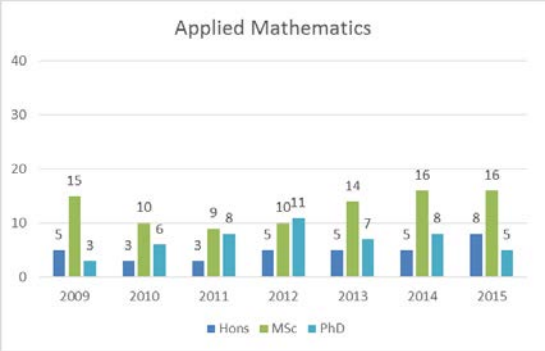
We have a full cohort of over a hundred full-time postgraduate students, with 10 Honours, 62 MSc and 35 Phd students in 2015. See tables below for a breakdown of postgraduate student numbers per division over the past seven years, as well as postgraduate student diversity in terms of race and gender:

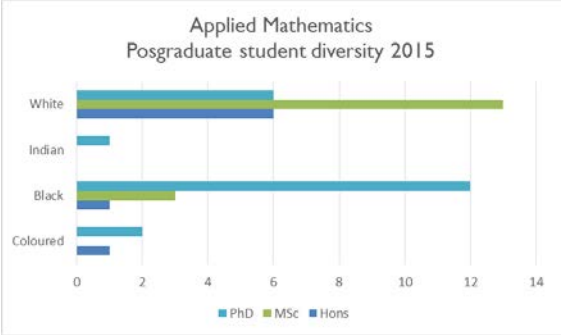


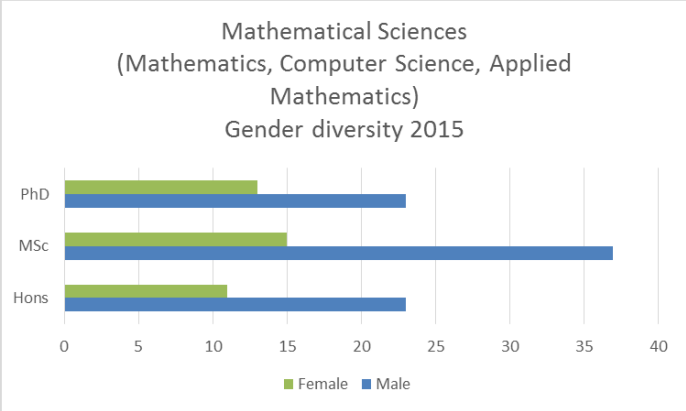












Staff list

Academic staff

Prof. IM Rewitzky (Executive head: Mathematical Sciences)
Prof. MK Banda
Dr B Bartlett
Mr W Bester
Dr G Boxall
Prof. F Breuer (Head: Mathematics Division)
Dr WH Brink
Dr J Brink
Ms EJ Burger
Dr J Coetzer
Dr H de Villiers
Dr GH Diedericks
Dr S Fidder-Woudberg
Prof. B Fischer
Prof. A Fransman
Prof. J Geldenhuys
Mr I Govender
Dr J Gray
Prof. BW Green (AIMS-SA)
Dr PJP Grobler
Ms HA Haroldt
Prof. BM Herbst
Dr K-T Howell
Dr CP Inggs
Prof. Z Janelidze
Dr AP Keet
Dr RS Kroon
Dr MF Maritz
Prof. S Mouton
Dr NL Muller
Dr CG Naude
Prof. F Nyabadza
Prof. H Prodinger
Dr D Ralaivaosaona
Dr R Roux
Prof. GJF Smit (Head: Applied Mathematics Division)
Mr JP Swanepoel
Prof. AB van der Merwe
Dr S van der Walt
Prof. L van Wyk
Prof. L van Zijl (Head: Computer Science Division)
Prof. W Visser
Prof. S Wagner
Ms L Wessels
Prof. M Wild

Extraordinary professors

Prof. MB Dwyer
Prof. T Krzesinski
Prof. HE Porst
Prof. JW Sanders

Extraordinary associate professors

Prof. K Scheffler
Prof. A Welte

Support staff

Mrs HA du Plessis (Computer Science)
Ms L Adams (Mathematics)
Ms W Isaacs (Mathematics)
Mr B Jacobs (Mathematics)
Mrs OM Marais (Mathematics)
MS Rabie (Mathematical Sciences)
Mrs MM Rhoda (Applied Mathematics)
Mr AL Roman (Applied Mathematics)
Mr D Stephanus (Computer Science)
Mrs M van Niekerk (Applied Mathematics)

Postdocs

Dr N Hale (Applied Mathematics)

New appointments

Dr Dirk Basson (Mathematics)
Retha Heymann (Mathematics)
Jacques Masuret (Mathematics)

DEPARTMENT OF MICROBIOLOGY

The Department of Microbiology's historical roots can be traced back to 1918 when plant pathology was recognised as a field of expertise in the then Faculty of Agrisciences. Today, the Department has an academic staff complement of 16 full-time researchers, extraordinary professors and research associates, working in eight research groups with their own state-of-the art laboratories.

RESEARCH INTERESTS

Biological processing of plant material	Taxonomy of lactic acid bacteria	Taxonomy of ascomycetes fungi	Environmental microbiology
Bioprospecting	Microbial ecology	Waste water treatment technologies	Energy research: biofuels

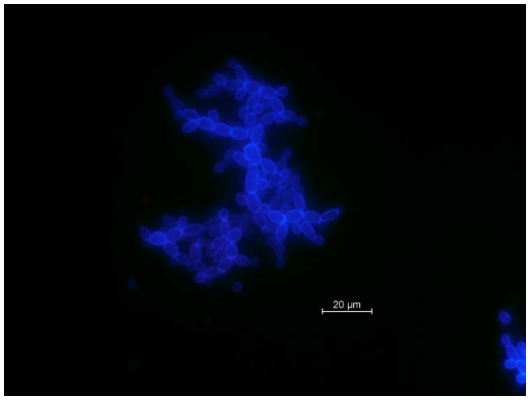
RESEARCH HIGHLIGHTS

Polluted water, malaria and opportunistic fungi

Prof. Alf Botha

Our research focuses on the interactions of fungi, including opportunistic fungal pathogens of mammals. With the advent of the HIV/AIDS epidemic in Africa, opportunistic fungal pathogens are spreading among the human population. Candidiasis, caused by the yeast *Candida albicans,* is the most commonly encountered fungal disease among hospitalised patients. Although *C. albicans* is generally associated with the microflora of healthy individuals, it is known that similar to other opportunistic *Candida* pathogens, it also occurs in sewage-polluted water from where it may spread to vulnerable communities. It is therefore important to understand what determines the survival of these pathogens in polluted water.

During 2015 MSc student Annica Steyn was the first to discover that mosquito larvae can use *C. albicans* as food. PhD student Eliska Benade demonstrated how this yeast is killed by bacterial enzymes and toxins in aerated water. However, under low oxygen conditions, like in the human gut, the same bacteria have no detrimental effect on *C. albicans.* These findings contribute significantly to current knowledge of the survival of *C. albicans* in polluted water.



A micrograph of the yeast Candida albicans stained with the fluorescent dye, calcofluor-white. This opportunistic pathogen of man was found to be eaten by mosquito larvae and killed by bacteria originating from the same polluted water as the yeast. Picture: Eliska Benade

A mosquito larvae, suspended in a water droplet, during the feeding trial in which the opportunistic pathogen Candida albicans was used as feed. Photo: Annica Steyn

Man, however, is not the only victim of pollution: it is well known that sewage pollution harms marine mammals and that fungal pathogens and toxic metals may be associated with such pollution. In 2015, we published results of a collaborative project focussing on the effect of toxic metals on the colonisation of whale skin by clinically relevant fungi. Dr Marnel Mouton conducted this research in collaboration with scientists at the Mammal Research Institute at the University of Pretoria and iThemba LABS. The study provided the first indications that elevated levels of some toxic metals, such as aluminium, contribute to immunotoxicity rendering the skin of false killer whales susceptible to colonisation by opportunistic fungal pathogens.

Rainwater harvesting for rural communities

Dr Wesaal Khan

One of the aims of the Millennium Development Goals (MDG) was to significantly increase access to safe drinking water and sanitation infrastructure by 2015. While good progress was made on the MDG, progress was slowest in Africa, where numerous countries did not meet the MDG target for water. The provision of a continuous and sustainable water source to rural and informal communities is thus a priority identified for South Africa, one of the signatories of the MDG. Rainwater harvesting (RWH), which involves the collection and storage of water from rooftops and diverse surfaces, is successfully employed worldwide and numerous RWH tanks have been installed by the Department of Water Affairs in South Africa, as local government has earmarked rainwater harvesting as a sustainable solution to water shortage.

The aim of our current research is to provide communities in urban informal settlements with sustainable access to water through the design, construction and monitoring of small- and large-scale domestic rainwater harvesting (DRWH) solar pasteurisation treatment systems, starting in Enkanini informal settlement, Stellenbosch. Enkanini was selected as the research site as it is currently estimated that 4450 residents inhabit this settlement with 32 communal taps each servicing 139 individuals. Ten households are involved in the research phase of the project. If these systems are successful at pilot scale, it will present a sustainable solution for access to clean drinking water for informal settlements and rural areas.

Representatives from ten households in the Enkanini informal settlement outside Stellenbosch attended the workshop held at the Enkanini Research Centre in September 2015. The workshop focused on rainwater harvesting, water uses and maintenance of the solar pasteurisation systems.

RESEARCH PROFILE

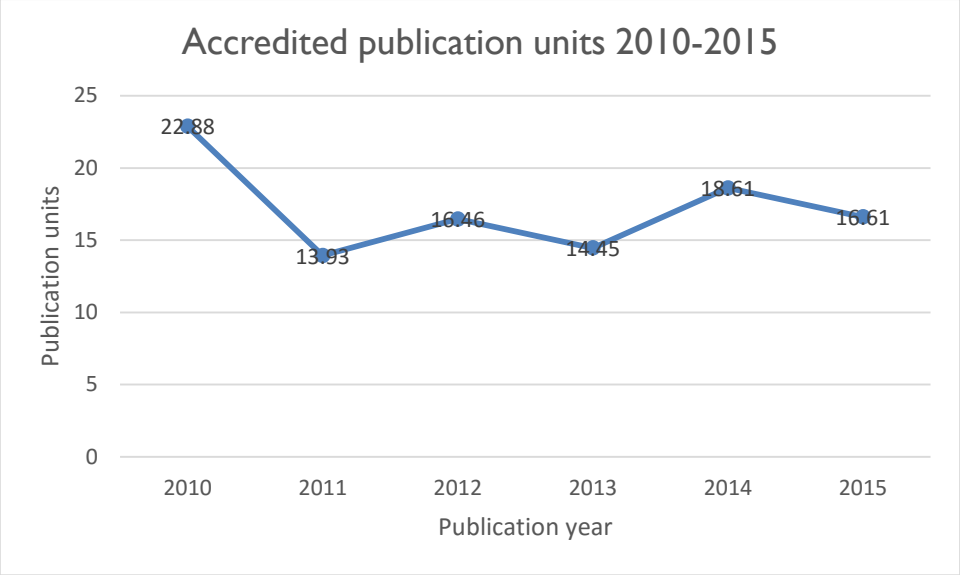
Research output

During 2015 staff published in high impact journals such as *PloS Pathogens* (7.562) and *Current Opinion in Biotechnology* (7.117):

- SCHWARTZ I, KENYON C, FENG P, GOVENDER NP, DUKIK K, SIGLER L, JIANG Y, STIELOW JB, MUNOZ JF, CUOMO CA, **BOTHA A,** STCHIGEL AM, DE HOOG GS. 50 years of *Emmonsia* disease in humans: the dramatic emergence of a cluster of novel fungal pathogens. *PloS Pathogens* 2015; 10:e1005198. doi:10.1371/journal. ppat.1005198.
- DEN HAAN R, VAN RENSBURG E, ROSE SH, GORGENS JF, **VAN ZYL WH**. Progress and challenges in the engineering of noncellulolytic microorganisms for consolidated bioprocessing. *Current Opinion in Biotechnology* 2015; **33**:3238.

Highly-cited articles over the past five years include:

- **48 citations**: Ilmén, M., Den Haan, R., Brevnova, E., McBride, J., Wiswall, E., Froehlich, A., Koivula, A., Voutilainen, S.P., Siika-Aho, M., La Grange, D.C., Thorngren, N., Ahlgren, S., Mellon, M., Deleault, K., Rajgarhia, V., **Van Zyl, W.H.**, Penttilä, M. High level secretion of cellobiohydrolases by *Saccharomyces Cerevisiae* (2011) *Biotechnology for Biofuels*, 4: 30.
- **39 citations: Botha, A.** The importance and ecology of yeasts in soil (2011) *Soil Biology and Biochemistry*, 43 (1), pp. 1-8.



Overview of research groups

Prof. WH van Zyl, M Viljoen-Bloom, T Jansen, H Volschenk

- Bioprocessing of agricultural products bioprospecting for enzymes, enzyme engineering and bioinformatics; genetic manipulation of yeasts for the conversion of plant material to bioethanol, nutraceuticals and production of enzymes in yeast and fungi

Prof. Leon Dicks

- Development of probiotic lactic acid bacteria for humans and animals taxonomy of lactic acid bacteria characterisation of antimicrobial peptides (including bacteriocins) produced by lactic acid bacteria and their industrial application; industrial and medical microbiology

Prof. Karen Jacobs

- Microbial communities from fynbos soil; taxonomy and biology of soil fungi, indoor air quality monitoring and fungal detection. Microbial community analyses of the GIT of various organisms

Prof. Alf Botha

- The interactions between yeast and their biological, chemical and physical environment

Prof. Gideon Wolfaardt

- Microbial biofilm ecology, and application of this knowledge to manage microbial aggregates in engineered, industrial and clinical settings

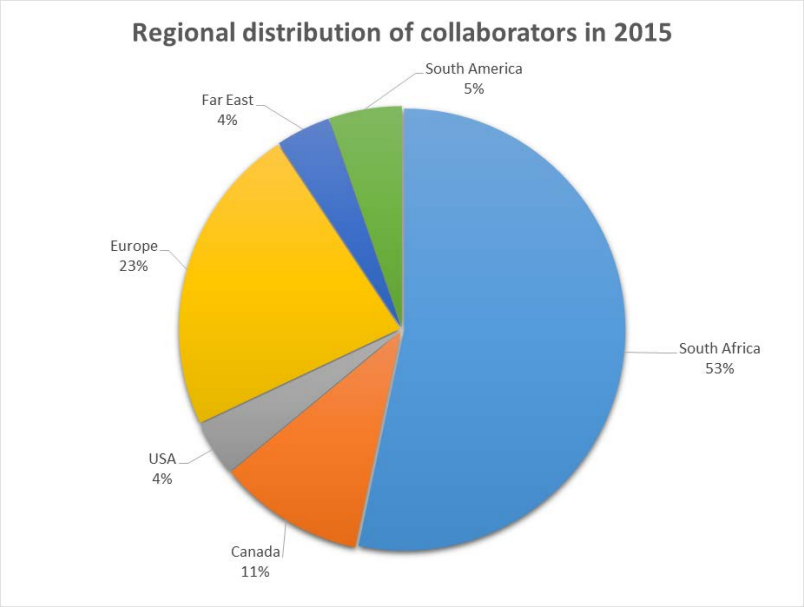
Dr Wesaal Khan

- Development and application of rainwater harvesting treatment systems; optimisation and monitoring of cost-effective point of use rainwater harvesting treatment systems

Collaboration

During 2015 researchers co-authored publications (research articles, book chapters and conference proceedings) with academics from 75 institutions in 18 different countries.

Prof. Wesaal Khan's research group is part of a collaborative research project, "Water: Sustainable Point-of-Use Treatment Technologies (WATERSPOUTT)", funded by the EU Horizon 2020 programme from 2016 to 2020. The project, with Prof. Kevin McGuigan from Royal Colleges of Surgeons in Ireland (RCSI) as the co-ordinator, is a collaboration between 16 research institutes based in Europe and Africa and focusses on designing, developing and piloting new integrated solar technologies for point-of-use drinking water treatment for rural communities without access to safe drinking water throughout the world.



Funding

South Africa

Cape Agency for Sustainable Integrated Development in Rural Areas (Casidra)
Cape Peninsula University of Technology
Claude Leon Foundation
East Rand Water Care Company
Fellowship in Sub Saharan Africa
Link Foundation
South African National Energy Research Institute
Stellenbosch University

International

Association of Medical Microbiology and Infectious Diseases Astellas Post Residency Research Fellowship
Brazilian National Council for Scientific and Technological Development
Canada Foundation for Innovation
Canada Research Chairs Program
Environment Canada
EU Grant BioDeep
EU Grant Mifriend
FONDECYT
Fonds de Recherche du Quebec nature et technologies
Fonds Wetenschappelijk Onderzoek Vlaanderen
Genome Canada
Innovative Agricultural Research Initiative
JINR NRS Grant
Marie Curie International Research Staff Exchange Scheme Grant
MECESUP
National Science and Engineering Research Council of Canada
NEPAD FAO project under the EU FAO Global Governance for Hunger Reduction Programme
NIGMS
PA and Alize Malan Trust
Regional Universities Forum for Capacity Building in Agriculture
Ryerson University, Canada
Sao Paulo Research Foundation, Brazil
Universidad De Antioquia Sostenibilidad
Universiteit Antwerpen
University Of Padova
Vid Universidad De Chile
Zurich Basel Plant Science Centre

Awards

Prof. Leon Dicks received the Havenga Prize in Life Sciences from the *Suid-Afrikaanse Akademie vir Wetenskap en Kuns* for his research on antimicrobial peptides and the probiotic properties of lactic acid bacteria. To date he has described 15 new species of lactic acid bacteria and 12 new novel antimicrobial peptides (bacteriocins). He is the first South African to publish ten chapters in *Bergey's Manual of Systematic Bacteriology*, a guide for bacterial classification and identification, and *The Prokaryotes*, a comprehensive overview of the taxonomy and physiology of bacteria (specifically lactic acid bacteria). His group was the first to incorporate the antimicrobial peptides of lactic acid bacteria in nanofibers and patented a nanofiber wound dressing with antimicrobial properties. Prof. Dicks is well known for the development of the probiotic entiro™. It is been patented in 65 countries and appeared on the South African market in 2013.

Dr Wesaal Khan finished second in the category: Distinguished Young Women Researchers in the Department of Science and Technology's (DST) Women in Science Awards which took place in Johannesburg on 13 August 2015. The Women in Science Awards are held annually to encourage and reward women scientists and researchers and to profile them as role models for younger researchers.

Mr Winschau van Zyl received the award for best poster at the ninth Biotechnology Congress of America which was held in Orlando, Florida, USA from 31 August - 2 September 2015.

Academic activities

Prof. LMT Dicks

- *Probiotics and Antimicrobial Proteins* (Associate Editor, 2008 - present); *Beneficial Microbes* (Associate Editor, 2008 - present); *Bioscience of Microbiota, Food and Health* (BMFH), the joint scientific journal of the Japan Bifidus Foundation, the Japanese Association for Food Immunology and the Japan Society for Lactic Acid Bacteria (2011 - present); *Annals of Microbiology* (2013 - present); Chief Editor of the *S.A. Journal of Enology and Viticulture* (editor since 2005)

Dr Wesaal Khan

- Together with two PhD students, Penelope Dobrowksy and Thando Ndlovu, they presented four posters at the 115th General Meeting of the American Society for Microbiology in New Orleans, USA, 31 May to 2 June 2015

Prof. Emile van Zyl

- Appointed as an expert on the National Advisory Council on Innovation (NACI) – Rapid Response Advisory Sub-committee on Energy

Prof. Douglas Rawlings

- Acted as national co-ordinator of the Claude Leon Foundation postdoctoral fellowship program
- External member of the review panel of the School of Life Sciences, University of KwaZulu-Natal

Social impact

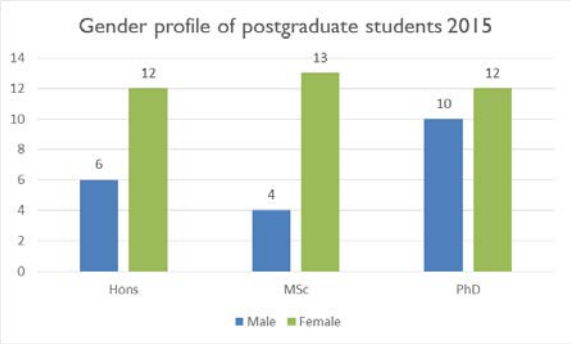
MSc students Brandon Reyneke and Monique Waso had the privilege of teaching the Grade 12 class of Bloemhof Girls High School about DNA extractions and the Polymerase Chain Reaction (PCR). This was a special practical demonstration to explain the application of all the theory the students discussed in class.

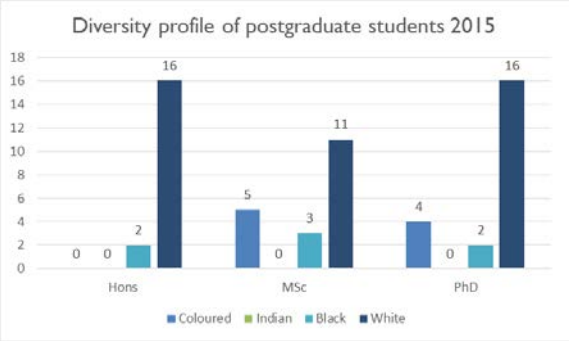
MSc student Steffi Davison is a volunteer tutor for primary school learners at Lynedoch Primary School. The Lynedoch project was established by United Nations Association of South Africa (UNASA) in collaboration with the Lynedoch Primary school, Matie Community Service (MGD) and Stellenbosch University. It strives to meet the Millennium Development Goal of achieving Universal Primary Education.

ACADEMIC AFFAIRS

Teaching and learning

In 2012 the Department of Microbiology had a five-year self-evaluation and as a resulted started to implement a programme-wide recurriculation exercise to reintroduce microbiology as a major subject with four final year courses to be phased in during 2014. At the same time, the department implemented an innovative approach of flexible practicals where students were divided into groups of five and allowed to do a short research project of their own choice in one of the third year courses. This, together with highly motived lecturers at both second and third year level, created so much enthusiasm amongst undergraduate students that the Department had a large cohort of 18 honours students in 2015. This again provided a great injection of new MSc students.





Staff matters

Prof. Douglas Rawlings retired after 17 years at the University of Stellenbosch. He joined SU in July 1998 as Chairman of the Department of Microbiology and continued in this capacity for the next 13.5 years until the end of 2011 with the exception of the years 2007 and 2008 when he acted as Dean of the Faculty of Science.

Prof. Doug Rawlings

Staff list

Academic staff

Prof. M Bloom
Prof. A Botha
Prof. TE Cloete (vice-rector: research and innovation)
Prof. LM Dicks (Distinguished Professor)
Prof. K Jacobs
T Jansen
Dr W Kahn
Prof. DE Rawlings (Retired end of 2015)
Prof. WH Van Zyl (Departmental chair, Distinguished Professor; Biofuels Research Chair)
Dr H Volschenk
Prof. GM Wolfaardt (Director, Stellenbosch University Water Institute and ERWAT Chair in Water Research)

Extraordinary professors

Prof. B Axcell
Prof. L Lynd
Prof. BA Prior
Prof. J Thevelein
Prof. D Toerien

Support staff

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

DEPARTMENT OF PHYSICS

The Department of Physics at Stellenbosch University has a proud history in physics, producing outstanding research and many excellent graduates since 1903. We offer focussed study programmes in nuclear, radiation and health physics, theoretical physics and laser physics on undergraduate and postgraduate level.

RESEARCH INTERESTS

Theoretical physics	Nuclear physics	Laser physics
• Condensed matter • Complexity	• Nuclear structure • Nuclear reaction mechanisms • Radiation and health physics • Applied nuclear physics • Physics education	• Spectroscopy • Ultrafast science • Quantam control • Biophotonics imaging • Laser technology

RESEARCH HIGHLIGHTS

15th anniversary of the Laser Research Institute

The Laser Research Institute (LRI) celebrated its 15th anniversary during 2015, which coincided with the International Year of Light as declared by UNESCO. Both events called for celebrations and outreach activities.

During July the LRI was involved in the organisation of a Photonics Winter school as part of the 60th annual conference of the South African Institute of Physics (SAIP). Two workshops for young researchers supported by the African Laser Centre (ALC) were organised and hosted by the LRI in December 2015:

- The ALC Spectroscopy Workshop, organised by Prof. Piet Walters, was attended by 10 lecturing staff and 23 students, of which 17 were foreign students. It focused on the applications of lasers in physics and chemistry. The delegates came from seven countries and represented eight institutions. The invited speaker was Prof. Tony Parker from the Central Laser Facility of the Rutherford Appleton Laboratory in the UK.
- The ALC Student Workshop provided opportunity for African Laser Centre grant holders to present their research and interact with local and international specialists. It was attended by 41 delegates from 14 countries and representing 12 institutions.

At the LRI Open Day on 22 September undergraduate students, school learners and public were treated to an "explorium" of hands-on experiments, guided visits to the research labs, a popular lecture and demonstrations. The LRI management hosted a dinner where the founders and

supporters of the LRI during the past 15 years were acknowledged. In November an informal braai with all the postgraduate LRI students concluded the year of festivities.

Physics for girls was promoted during a "Physics Day for Bright Sparks" where top performing grade 11 girls from 12 local schools were inspired by the stories of two women in physics careers and explored hands-on experiments.

Short history of the Laser Research Institute

The LRI was founded in 2000 with Prof. Piet Walters, Prof. Hubertus von Bergmann and Prof. Erich Rohwer as founding members. In its early years the LRI members were involved in the establishment of the CSIR National Laser Centre, and the LRI was one of the founder members of the African Laser Centre. The institute has since then grown to an academic membership of eight (with two emeritus members in addition) and accommodates 25-30 postgraduate students per year. LRI members and their collaborators have produced nearly 100 journal papers during the past 15 years. Achievements over the 15 years included the building of the first sub-picosecond fibre laser, the first observation of hole dynamics in silicon, the first experiments with ultra-short electron pulses in Africa, a SARCHI Research Chair, a CSIR Research Chair, and we are looking forward to the first ion trapping experiment in Africa that should be operational soon.

Group photo of LRI members, students and visitors in October 2015. Photo: Anton Jordaan

Participants in the African Laser Centre's student workshop hosted by the Department of Physics at SU.

New SU/CSIR research chair in quantum optical and atomic physics

Stellenbosch University (SU) and the Council for Scientific and Industrial Research (CSIR) launched a new research chair in quantum, optical and atomic physics in Stellenbosch on Monday (20 July 2015). The launch was held as part of a SU/CSIR research seminar that focused on particular areas where expertise exists at both institutions.

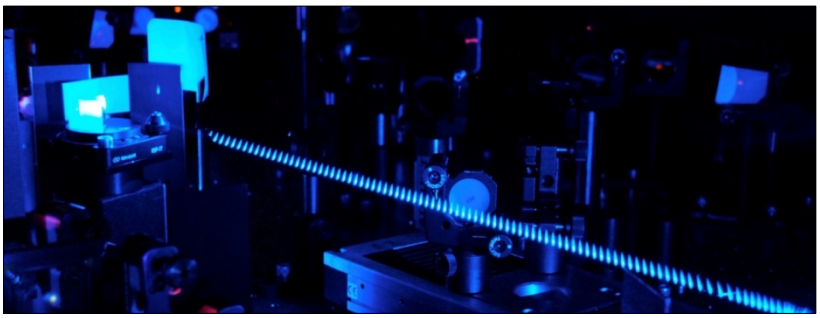
The chair, held by Dr Hermann Uys, will allow researchers to focus on the use of single trapped atomic ions for studying quantum phenomena and on developing laboratory technologies for the field of research that can be commercialised. During 2015 the group focussed on the establishment of a laboratory and development of an ion trapping experiment in Stellenbosch. The setup that is close to becoming operational will be the first ion trapping experiment in Africa.

Short pulses of super white light for microscopy

Prof. Erich Rohwer, Dr Pieter Neethling and Dr Dirk Spangenberg

In microscopy, bright white light, perfectly focussed and arriving at the exact spot and a precise time, is the ideal. If the light can be delivered in short pulses, the sample lasts longer due to less heating.

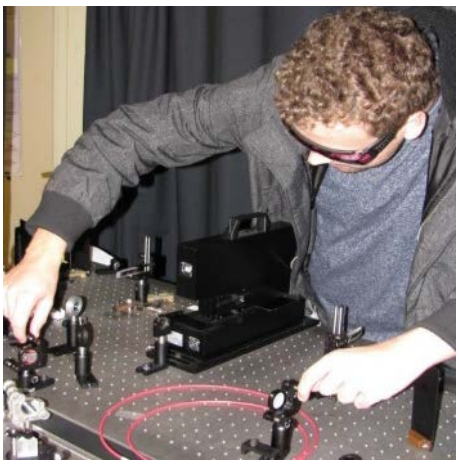
Using laser beams in microscopy improves the resolution of microscopic images and allows the detection of features at different depths in a sample. It also allows nonlinear microscopy where the light coming from the sample is a different colour than the incident light and comes from a spot that is much smaller than the smallest achievable laser spot. The change in colour allows scattered light to be eliminated easily giving clearer images and the small spot increases the resolution of the image.



We collaborated with Prof. Thomas Feurer from the University of Bern (Switzerland) to develop a completely novel method to measure the complete characteristics of laser pulses. Having this information the laser pulses can be shaped and controlled to have the desired properties for application in imaging and microscopy.

We have also been applying a special optic fibre, called a photonic crystal fibre, to generate white light containing a large range of wavelengths. Using a spatial light modulator, the white light can be compressed into very short pulses. It can also be manipulated to form a focal point at a desired position in the beam path. This makes it ideal for application in microscopy.

Dr Dirk Spangenberg in action in the laboratory



Making white light in an optic fiber. MSc student Ruan Viljoen in action.

FOCUS ON: Research chairs and Centres of Excellence

South African Research Chair in Photonics and Ultrafast Laser Science

Prof. Heinrich Schwoerer

We pursue two major activities in the chair: one on charge dynamics in novel organic and hybrid organic/inorganic solar cells.

Dye-sensitised solar cells have the potential to provide solar energy at higher efficiency and lower cost to the environment. During 2015 we made a breakthrough in understanding the complex processes in these cells by using infrared light to study the fast changes.

We used our femtosecond transient absorption apparatus to observe electron propagation from photo excited organic molecules through intermediate states into the charge acceptor of the solar cell. Velocity and yield of these initial fundamental processes ultimately determine the cell's efficiency to convert sunlight into electricity. In collaboration with electrochemists we modify the cells on a molecular level in order to optimise the light-induced charge transfer. This project involves both fundamental physical chemistry aspects as well as applied cell manufacturing and engineering, which makes it popular amongst the postgraduate students. One of our research articles made it onto the cover page of the international journal *ChemPhysChem*.

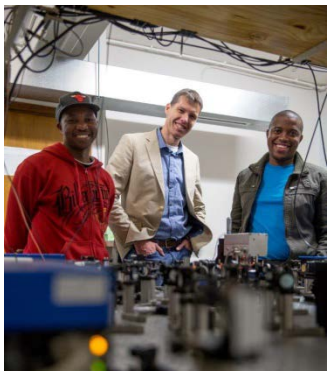
The group also used laser light to create ultra-short pulses of electrons. Imaging the electrons after they have passed through a thin crystal, the exact crystal structure can be calculated and fast changes in the crystal structure can be detected. The group focusses on crystals that undergo instantaneous transitions from a metal-type crystal to an insulator-type crystal at a specific temperature well below freezing point. We investigated structural phase transition in strongly correlated condensed matter, which are related to macroscopic electronic properties such as metal-insulator transitions, magnetism or even superconductivity. As with the solar cell project, observation of the pathway of chemical and physical processes on an atomic level reveals the driving forces behind processes, and might answer the question why they occur.

For this purpose we have built one of the first cryogenic electron diffraction microscopes with a temporal resolution of better than 10^{-12} seconds, which allows us to follow photo-induced dynamics of crystal lattices in real time

Research Chair in Quantum, Optical and Atomic Physics

Dr. Hermann Uys

In 2015 Stellenbosch University and the Council for Scientific and Industrial Research (CSIR) jointly established a research chair in quantum, optical and atomic physics, led by Dr. Hermann Uys. The chair aims to study fundamental aspects of control of quantum mechanical systems, particularly single trapped atoms and their use as ultra-precise probes of various physical phenomena such as time or frequency in atomic clocks. Simultaneously, a strong emphasis is placed on the development of novel laboratory instrumentation with commercialisation potential.



Dr Hermann Uys (middle) with PhD student Naleli Matjelo (left) and postdoctoral fellow Dr Ncamiso Khanyile (right). Photo: CSIR

The first year of the chair focused on infrastructure establishment and laboratory build-up. Currently, the group consists of two post-docs, two PhD students and one MSc student. During 2015 two PhD students successfully completed their degrees.

The group also produced one peer-reviewed article on methods for estimating quantum dynamics, made five contributions to national and international conferences, hosted several vacation students, and, as part of the International Year of Light celebration, Dr Uys presented a public talk titled "Reflections on Light through Arts and Science" at the artSPACE Gallery in Durban and at the SU physics open day.

Institute of Theoretical Physics

The Institute of Theoretical Physics is the home to many of the theoretical physics of the Department of Physics. Founded in 1984, the fundamental objectives of the Institute are to undertake research projects in theoretical physics, to assist in the education of graduate students and to provide a centre for the development and co-ordination of activities in theoretical physics in the Physics Department. Together with members of the Stellenbosch hub of the National Institute for Theoretical Physics we do wide variety of research on quantum, statistical physical and biological systems. Our research topics include studies of solitons in field theory, quantum phase transitions and exceptional points, gauge theories, complex systems, and many more.

Highlights from the past year include:

Heavy Baryon Resonances:

Heavy baryon resonances are at the frontier of current research in particle physics. Quantum-chromo-dynamics (QCD) in the fundamental theory that describes the binding of quarks and gluons to baryons is too complicated to be solved in the non-perturbative sector. We therefore resorted to the solvable Skyrme soliton model to explore the spectrum of baryons that have a valence quark content of one heavy (charm, bottom) quark and two light (up, down, strange) quarks. Though soliton models do not precisely reproduce empirical data, they are very useful to classify the states within the spectrum and thus to reliably assign quantum numbers to observed resonances in ongoing

experiments as, for example, at the large hadron collider (LHC) at CERN. (J. P. Blanckenberg, H. Weigel: "Heavy Baryons with Strangeness in a Soliton Model" *Phys. Lett.* B750 230 (2015).

Resonances and level coalescence:

Three papers have appeared relating to exceptional points and levels coalescence in systems, including often the celebrated Fano resonances occurring in nuclear, atomic and molecular physics, a system relevant to three coupled wave guides, and scattering functions for higher order exceptional points.

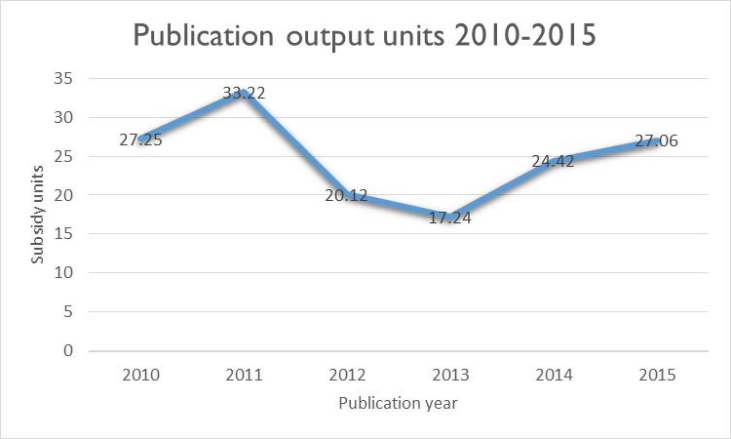
Biological physics

The role of confinement on the arrangements of filaments within a confined region, such a cytoskeleton within a cell, was investigated through extensive simulations. The study showed interesting separation phenomena (A. Azari, K.K. Müller-Nedebock: Entropic competition in polymeric systems under geometrical confinement. *EPL* 110, 68004 (2015).

RESEARCH PROFILE

Research output

During 2015 the Department's researchers have maintained a steady upward climb in terms of the number of subsidised publication units since 2013.



Since 2010, researchers and postgraduate students have published in several high-impact journals including *Nature Communications* (11.47), *Angewandte Chemie International Edition* (11.261), *Journal of High Energy Physics* (6.111), *Advances in Atomic Molecular and Optical Physics* (5.875), *Journal of Cosmology and Astroparticle Physics* (5.81) and *Monthly Notices of the Royal Astronomical Society* (5.107).

Highly-cited article

Cited 88 times: Heidt, A.M., Hartung, A., Bosman, G.W., Krok, P., Rohwer, E.G., Schwoerer, H., Bartelt, H. 2011. Coherent octave spanning near-infrared and visible supercontinuum generation in all-normal dispersion photonic crystal fibers. In *Optics Express* 19(4):3775-3787.

NRF-rated researchers

Leading international researcher	Prof. Anthony Cowley	Mechanism of proton-induced pre-equilibrium nuclear reactions, alpha-particle clusters in atomic nuclei and light-ion transfer reactions
	Prof. Hendrik Geyer	Quantum mechanics and the quantum mechanical many-body problem
	Prof. Dieter Heiss	Physical effects and significance of spectral singularities
	Prof. Hugo Touchette	Applying the theory of large deviations to predict and understand the response and fluctuations of many-particle systems driven away from equilibrium by forces or external reservoirs
	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. Fredrick Scholtz	Non-commutative quantum mechanics and quantum field theory
	Prof. Heinrich Schwoerer	Ultrafast charge and energy dynamics in organic matter, organic photovoltaics, structural dynamics in strongly correlated materials
	Prof. Michael Kastner	Quantum many-body physics; geometric and topological aspects of (quantum) phase transitions; magnetism and spin systems; quantum statistical physics applied to atomic physics (as it is of relevance for atom- or ion-trap-based quantum simulators of many-body systems)
Established researcher	Dr Fabio Cinti	Quantum many-body problems: superconductivity, superfluidity, supersolidity and Bose condensation in condensed matter systems and ultra-cold quantum gases
	Prof. Kristian Müller-Nedebock	Uses methods of equilibrium and nonequilibrium statistical physics in understanding polymers and biological systems, such as filament networks, active systems and physics of cellular structures
	Prof. Hubertus von Bergmann	Pulsed carbon dioxide lasers and their applications; development of novel excitation and discharge stabilisation techniques for pulsed gas lasers
	Prof. Hans Eggers	Bayesian analysis in physics, data analysis, experimental high energy physics
	Prof. Paul Papka	Clustering in nuclei is observed for a wide range of masses but particularly well in light nuclei. My research focuses on a selection of light N=Z nuclei for which clustering has structural implications and plays a crucial role 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. Erich Rohwer	Laser development, laser techniques and applications, laser spectroscopy and microscopy
	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
	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
	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
Promising young researcher	Dr Pieter Neethling	Using linear and nonlinear spectroscopic techniques to address problems in solid state physics, biochemistry and chemistry

Funding

South Africa

Claude Leon Foundation, South Africa
Council for Scientific and Industrial Research, South Africa
Council for Scientific and Industrial Research, National Laser Centre, South Africa
National Research Foundation, South Africa
Department of Science and Technology's Hydrogen South Africa Program
Eskom Tesp Programme
Innovus, South Africa
National Institute for Theoretical Physics NITHEP South Africa
Square Kilometer Array Project South Africa
Stellenbosch University

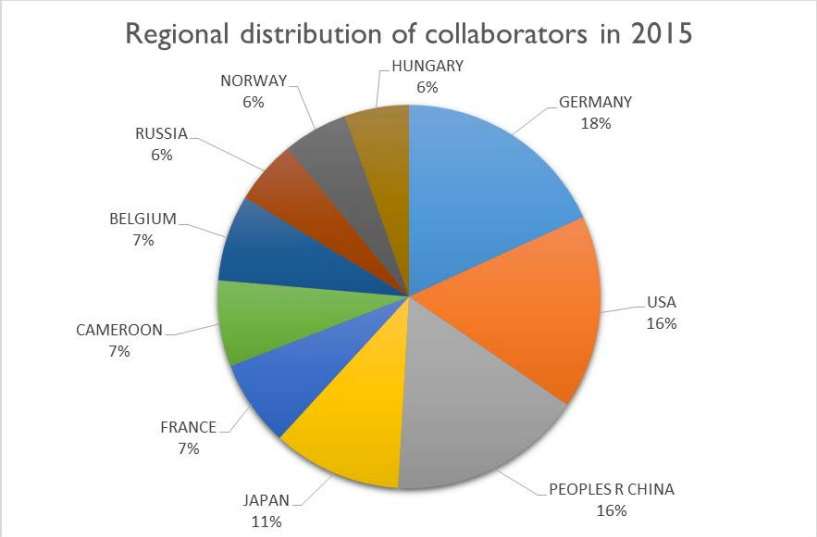
International

ANR Stosymap
Austrian Science Fund
Chinese Academy of Sciences
Chinese Major State Basic Research Development Program
Council of Scientific and Industrial Research, India
DFG Cluster of Excellence Origin and Structure of the Universe
EOARD
ERC St Grant Coldsim
EU Cost Actions
F R S FNRS
Fundamental Research Fund For The Central Universities
Galileo Galilei Institute for Theoretical Physics
Harry Crossley Foundation
INFN
Innovation Foundation of Beihang University
Kavli Institute for Theoretical Physics
Laboratoire J A Dieudonne
Major State 973 Program Of China
Maryland Center for Fundamental Physics
National Natural Science Foundation of China
National Science Foundation
National Undergraduate Training Programs for Innovation and Entrepreneurship
Natural Science Foundation of China
NCCR Must Research Instrument of Swiss National Science Foundation
New Century Excellent Talents in University Program of Ministry of Education Of China
NNR
Research Council of Norway

Research Fund for the Doctoral Program of Higher Education RFDP
Riken Foreign Postdoctoral Researcher Program
Riken Ithes Project
RYSQ
SA China Research Collaboration in Science and Technology
Studienstiftung Des Deutschen Volkes
Tohoku University Focused Research Project
Understanding the Origins gor Matters in Universe
U S Department Of Energy DOE Office of Science Office of Nuclear Physics
UDS Via IDEX
University Development Cooperation VLIR Own Initiative Programme
US Air Force Office of Scientific Research
Wilhelm Frank Bursary Trust

Collaboration

During 2015 researchers co-authored 60 publications (including research articles, book chapters and conference proceedings) in collaboration with researchers from 35 institutions in 10 different countries.



Members of the Nuclear Physics group hosted Professor S.S. Dimitrova, a visiting collaborator from the Institute for Nuclear Research and Nuclear Energy, Sofia, Bulgaria. Prof. Dimitrova is part of a research group lead by Prof. Anthony A Cowley, an Extraordinary Professor in the Physics Department, investigating inclusive and discrete multinucleon transfer reaction mechanisms. During her visit in November 2015, Prof. Dimitrova presented a seminar talk and engaged in continued discussions and planning of future research. The visit was made possible through financial support from the Division of Research Development, iThemba LABS, and the Knowledge, Interchange and Collaboration (KIC) grant of the NRF.

The nuclear physics group's Prof. Richard Newman initiated collaboration with VTT (a technical support organization to the nuclear industry in the Finland). As part of this collaboration, Ms Tarryn Ackerman has started working on an MSc project related to reactor decommissioning. Ms Ackerman is registered as a student at SU.

Prof. Richard Newman and Prof. Shaun Wyngaardt visited the Gran Sasso Underground Laboratory (LNGS) in Italy in July 2015. They were accompanied by Dr M.R. Nchodu (Head of the Department of Nuclear Physics at iThemba LABS NRF). The aim of the visit was to provide feedback into a current project, namely that of developing a South African Underground Laboratory. Discussions were held with, amongst others, Dr Roberta Antolini (LNGS Communications Manager) and Prof. Stefano Ragazzi (LNGS director). The LNGS provided partial funding for the visit.

Prof. Schwoerer also intitiated collaboration with Prof. Mammo Wendimagegn, a well-known synthetic chemist based in Addis Ababa and PhD supervisor to Ms Neway Tegegne. Prof. Wendimagegn has strong ties with the Universities of Linkopping and Chalmers in Sweden. The initiative resulted in a small workshop on the physics, chemistry and technology of solar cells in Addis Ababa from 30 September to 1 October 2015.

Other collaborators include:

South Africa

Dr Karel von Eschwege, Department of Chemistry, University of the Free State, Bloemfontein
Prof. Andrew Forbes, CSIR National Laser Centre and the University of the Witwatersrand
Prof. Thomas Konrad, University of KwaZulu-Natal
Dr Kessie Govender, Cape Peninsula University of Technology
Dr Benjamin Loos, Department of Physiological Sciences, Stellenbosch University

International

Africa

Dr Peter Baricholo, Department of Applied Physics, University of Science and Technology (NUST) Bulawayo, Zimbabwe

Germany

Prof. Herbert Stafast, Prof. Hartmut Bartelt, Institut fur Photonische Technologien (IPHT Jena) Jena
Prof. Derck Schlettwein, Universitat Giessen
Prof. Markus Schwoerer, Universitat Bayreuth
Prof. Jens Pflaum, Universitat Wurzburg
Prof. Jure Demsar and Maximiliam Eichberger, University of Konstanz
Dr Kai Rossnagel, University of Kiel

Switzerland

Prof. Thomas Feurer, University of Bern
Dr Alex Heidt, University of Bern

Sweden

Dr Mikkel Brydegard. University of Lund

United Kingdom

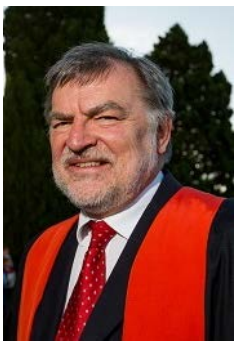
Prof. Tony Parker, Central Laser Facility, Rutherford Appleton Laboratory
Prof. Stanley Botchway, Central Laser Facility, Rutherford Appleton Laboratory
Prof. Tanniemola Liverpool, Department of Mathematics, University of Bristol

United States of America

Prof. M. Cristina Marchetti, Department of Physics, Syracuse University

Awards

Prof. Hendrik Geyer was awarded the SU's Chancellor's Award for outstanding achievement during the December 2015 graduation ceremony. He is currently director of the Stellenbosch Institute for Advanced Studies (STIAS) and a former director of the Institute of Theoretical Physics and the National Institute of Theoretical Physics.



Prof. Hendrik Geyer

Mr Alem Gebru, a Phd student in laser physics, won the 'Falling Walls Lab' national event and represented South Africa in the final in Berlin, Germany on 8 November 2015. He developed a technique to remotely classify insects based on the frequency of their wing beats and iridescence features. The instrument, using laser radar and sunlight, can also determine their sex and the direction of flight. He also participated in SU's "New voices in Science" communication programme and was one of the 22 finalists who gave presentations at the annual event.

PhD student Alem Gebru in action during SU's New Voices in Science competition.

Eight members received recognition from Stellenbosch University for excellent performance when they were awarded the SU Rector's Performance Award for 2016. They are SH February, GJ Louwrens, Dr PH Neethling, Prof. P Papka, Prof. EG Rohwer, Ms C Ruperti, Dr JJ van Zyl and Prof. H Weigel.

Mr Philipp Uhrich received the Meiring Naudé medal for the best Honours student in Physics in 2015, and Mr Kevin Li the John Todd Morrison medal for the best MSC student in Physics in 2015.

Our students performed exceptionally well at the annual conference of the South African Institute of Physics:

- Kevin Li, Best oral presentation by MSc student in Nuclear, Particles and Radiation Physics, Nuclear research group, Stellenbosch University
- Xavier von Stein, Best oral presentation by MSc student in Photonics, Laser Research Institute, Stellenbosch University
- Janusz Meylahn, Best oral presentation by MSc student in Theoretical and Computational Physics, Institute for Theoretical Physics, Stellenbosch University
- Alem Gebru, Best oral presentation by PhD student in Photonics, Laser Research Institute, Stellenbosch University
- André de Bruyn, Technology Prize by MSc Student in Photonics, Laser Research Institute, Stellenbosch University

Service to the scientific community

During the annual South African Physics Institute conference held in Port Elizabeth members of the Laser Research Institute were responsible for organising a photonics winter school. Dr Gurthwin Bosman, Dr Pieter Neethling, Dr Hermann Uys and Prof. Erich Rohwer also actively contributed to the presentations. The LRI student chapter contributed by presenting a special optics demonstration as part of the International Year of Light celebrations. They also organised a laser show to entertain the SAIP members.

Other activities include:

Prof. Erich Rohwer South African Institute of Physics (SAIP) Photonics Division (chair); Photonics Initiative of South Africa (PISA) (steering committee)
Prof. Hendrik Geyer Stellenbosch Institute for Advanced Studies (STIAS) (director)
Dr Hannes Kriel African Institute for Mathematical Sciences (executive team)
Prof. Kristian Müller-Nedebock South African Institute of Physics (SAIP) (board member) SAIP Computational and Theoretical Physics Division (chair) School on Geometry and Topology in Soft Matter, Optics and Biological Systems, South Africa (local organiser)
Prof. Richard Newman Physics Advisory Committee for the Separated Sector Cyclotron Facility at iThemba LABS (member)
Prof. Frikkie Scholtz National Institute for Theoretical Physics (NITheP) (director) South African Institute of Physics (SAIP) (board member) SAIP Theoretical Physics Division (chair)
Prof. Heinrich Schwoerer Laser Research Institute SU (director) Chaired the fourth Banff Meeting on Structural Dynamics, Canada, 15 to 18 February 2015 Postgraduate students Bart Smit and Iulia Minda assisted Prof. Schwoerer in organising the group's third international PhD and postdoctoral workshop, New Trends and Faces: Photophysics in Organic Matter, from 19 to 23 October 2015 at STIAS. The speakers covered topics from structural dynamics of organic crystals (Stuart Hayes, Bart Smit), organic solar cells (Lydia Cabau, Getachew Adam, Armantas Melianas, Iulia Minda), photosynthesis and single molecule spectroscopy (Lisa Gunther), electron spin filter based on organic molecules (Matthias Kettner), metal-organic networks (Charl Bezuidenhoud) and protein dynamics (Udo Heintz)
Prof. Hubertus von Bergmann African Laser Centre (director)
Prof. Shaun Wyngaardt and Prof. Richard Newman Participated in the Nuclear Industry Congress 2015 held at the President Hotel in February 2015 and Prof. Wyngaardt gave an invited talk on "Towards the South African Underground Laboratory"
Mr Joram Ndayishimye (PhD student) Attended the conference on Chiral Bands in Nuclei in Stockholm, Sweden, 20 to 22 April 2015. This conference focused on the present theoretical and experimental status regarding chiral bands in nuclei. New observations and theoretical approaches, interaction between theory and experiments, and future collaboration projects were discussed

Social impact

Celebrating the International Year of Light

The Department of Physics at Stellenbosch University celebrated the International Year of Light with a series of events for students, learners and the public to learn more about this fascinating topic

On Tuesday 22 September 2015 learners, students and the public were invited to explore and enjoy the "explorium" in the Merensky Building and visit the laser research laboratories with postgraduate students in physics as guides.

On Monday 22 September Dr Hermann Uys, who holds the new research chair in quantum, optical and atomic physics at Stellenbosch University, delivered a public lecture on "Lights for Artists" in the

Merensky Building. This was followed by demonstrations of surprising light phenomena, discussions and refreshments.

Women in Physics

Female students interested in following a career in physics attended the Women in Physics in South Africa discussion and luncheon on 24 September 2015. The event was organised by Dr Christine Steenkamp, with financial support from the South African Institute of Physics (SAIP) Women in Physics in South Africa (WiPiSA) project.

Bright sparks at physics open day

Nearly 70 girl learners, selected on the basis of their marks in mathematics and physical sciences, were invited to participate in the Department of Physics' Open Day activities for Bright Sparks.

During the event the learners met with women physicists Dr Daphney Bucher from iThemba LABS and Dr Melanie McLaren from the University of the Witwatersrand. Under the guidance of postgraduate students and lecturers in physics, they also had an entire morning to explore a variety of experiments set out in the department's laboratories. Experiments ranged from transmitting music over a laser beam, to bending a stream of water without touching it, to steering a laser beam through a maze.

Participating schools were: Ixolo High School, Bridge House, New Orleans Secondary, Rhenish School for Girls, Bardale Secondary School), Kylemore High School, Uxolo High School, New Orleans Secondary, and Aloe High School. Dr Christine Steenkamp organised the event as part of the South African Institute for Physics (SAIP) Women in Physics in South Africa programme and in celebration of the International Year of Light.



Stellenbosch Laser Student Chapter

During 2015 the chapter's activities had a strong focus on the International Year of Light (IYL2015). We visited several schools in the Stellenbosch area with optics demonstration and outreach activities.

The chapter made significant contribution to the demonstrations at the annual Physics open day on 21 April, and again at the International Year of Light event, celebrated together with the LRI open day in September. During both events the laboratories were opened for guided tours.

The annual road trip took place during the September break during which we visited eight schools in the Eastern Cape where we presented physics and optics demonstrations and created an awareness of science. This road trip was sponsored by the Laser Research Institute (LRI), Optical Society of America (OSA), SPIE (international society for Optics and Photonics), National Institute for Theoretical Physics (NITheP) and the Dean's Office for the Faculty of Natural Sciences.

One of the winning photographs of light phenomenon.

The IYL 2015 photo competition was launched to celebrate the International Year of Light. Students and the general public had to upload their most beautiful light phenomenon-picture on a social medium and they stood a chance to win amazing prizes such as high-end (digital) cameras. The prize-giving ceremony took place on 22 September to coincide with the department's celebration of the IYL. The students also presented demonstrations during the SAIP Photonics workshop in July, the ALC laser spectroscopy workshop (Stellenbosch) and the annual ALC student workshop (Zevenwacht) in November.

ACADEMIC AFFAIRS

Teaching and learning

Finlo Project: ePhys resource for Physics 114

This project pioneers the use of an online resource in the mainstream physics first year module to help to bridge the gap between the academic skills and approach cultivated in school and what is required to succeed in first year calculus-based physics.

After evaluation of commercial resources it was decided to develop a custom online resource, called ePhys, from scratch. The content and approach, and how the source would be used was determined taking into account feedback from the 2015 F114 class and was finalised during discussions with the lecturers involved with Physics 114 during 2015 and 2016. The company Knowbrainer was contracted to develop the structure of the resource in Moodle. Dr Steenkamp and Dr Kriel developed the content.

By January 2016 the ePhys resource was transferred to the SU server and during the first week of class the Physics 114 students were given access. The topics covered in the resource are "functions and derivations" (including notation, algebra and graphs), "vectors" (including vector algebra) and "calculus" (differentiation and integration). Students were encouraged, by bonus marks, to work through the content and submit the quizzes.

By the time of the early assessment 75% of the students have completed most of the quizzes, and only 9% have not submitted any quiz. The students will be asked to complete a questionnaire at the end of the semester to determine their experience of the resource. The resource is part of a larger intervention in F114 that also includes:

- tutorials every week

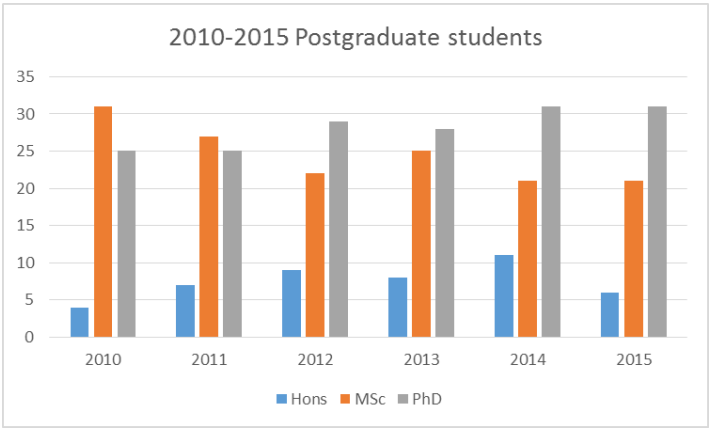
- differentiated tutorials for students at risk
- consultation opportunity with a lecturer or tutor during every week day lunch hour
- three lunch-hour feedback sessions to discuss the early assessment
- a staff member (Dr Bosman) acting as mentor for the class.

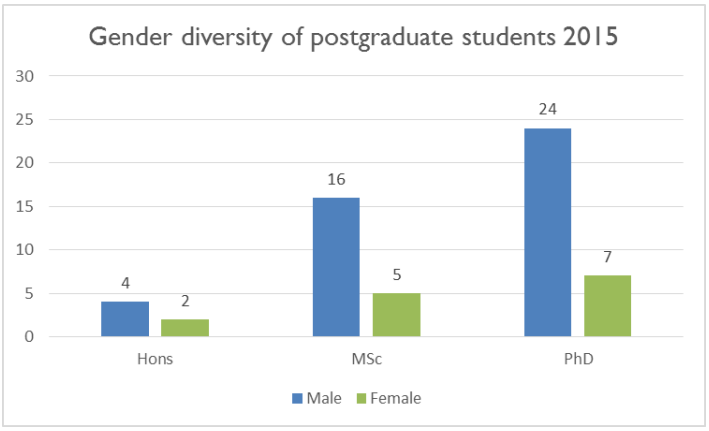
The class average of the recent F114 early assessment has been 55%, which is approximately 15% higher than in 2015, but this cannot be attributed to a single factor.

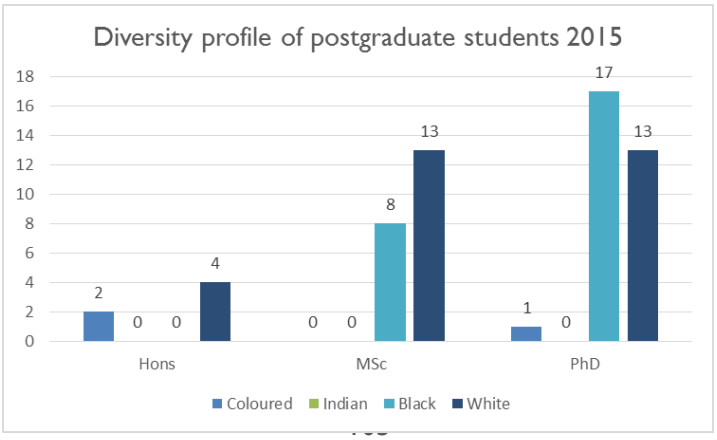
Focus on postgraduate students

During 2015 the Department delivered six Honours, seven MSc and ten PhD graduates.

The Department hosted seven postdoctoral fellows. They are Dr Philip Adsley (United Kingdom), Dr Ncamiso Khanyile (Swaziland), Dr Roy Analabha (India), Dr Conrad Tabi (Cameroon), and from South Africa Dr Jacobus Diener, Dr John Anslyn and Dr Dirk-Mathys Spangenberg.







BSc Alumni: Tribute to SU alumnus Simon Marais

Hendrik Geyer, director: STIAS

It was with shock that we learned about the passing last week of Dr Simon Marais (50), founder and chairman of Allan Gray (Australia). Hailed in business circles as a "contrarian and activist", but also as "a gentle giant … well-liked and hugely respected by everyone who knew him – including his enemies".

The late dr Simon Marais

A giant Simon certainly was, but closer to home in Stellenbosch and at STIAS this was not in the first instance linked to his prowess in business and investment, nor his towering at two metres, but rather to his intellectual capacity and originality. Simon was a member of the remarkable 1986 Honours class in theoretical physics at Stellenbosch University, who have all since made their mark in South Africa and internationally, primarily in physics or related fields.

I had the privilege that year of teaching the course on quantum field theory and particle physics – Simon's grasp and originality of thought was in a class of its own. He continued to complete a master's degree in theoretical physics at Stellenbosch under the supervision of the late Prof. Chris Engelbrecht, graduating *cum laude* with a thesis on "A comparison of quark distributions in bound and free nucleons". Subsequently Simon completed a PhD in theoretical condensed matter physics at Cambridge University, and returned to South Africa in 1991, initially to take up a postdoctoral position in theoretical physics at Stellenbosch. At that time he met and joined founder Allan Gray and made a career choice – the rest is, well, history. Simon was instrumental in establishing contact between the Stellenbosch Institute for Advance Study (STIAS) and the Trellis Charitable Trust, procuring two major grants awarded by the Trust to STIAS, the first in 2010. At a time when the STIAS programme was still rather precariously positioned, this made every difference.

Dr Simon Marais (front right) was part of the 1986 Honours class in theoretical physics at Stellenbosch University. He went on to become the founder and chair of Allan Gray in Australia and heralded as one of the country's best-known and rebest-known and respected investors. At the back, from left to right, Evan de Kock, Fritz Hahne, Jean Joubert, Frederik Scholtz, Hendrik Geyer, Chris Engelbrecht, Cecile Thom, Jan Engelbrecht and Jacqueline Marais. In the front, seated, Pierre Lacock and Simon Marais.

STAFF LIST

Academic staff

Prof. EG Rohwer (Executive head)
Dr GW Bosman
Prof. HC Eggers
Mr D Geduld
Prof. HB Geyer
Dr H Kriel
Prof. KK Müller-Nedebock
Prof. PH Neethling
Prof. RT Newman
Prof. P Papka
Prof. FG Scholtz
Prof. HPH Schwoerer
Dr CM Steenkamp
Dr H Uys
Prof. BIS van der Ventel
Dr JJ van Zyl
Prof. H Weigel
Prof. SM Wyngaardt

Extraordinary Professors

Prof. AA Cowley
Prof. A Forbes
Prof. WD Heiss
Prof. J Meng
Prof. T Parker
Prof. H Stafast
Prof. Z Vilakazi
Prof. HM von Bergmann

Professors Emeritus

Prof. PR de Kock
Prof. PE Walters

Support staff

Ms C April
Mr DP Pool
Ms C Ruperti
Ms E Bosch

Technical staff

Mr MC Botha
Mr J Burns
Mr PC Cornelissen
Mr SH February
Mr JM Germishuizen
Mr GJ Louwrens
Mr DP Pool
Mr EJ Shields
Mr MC Botha

DEPARTMENT OF PHYSIOLOGICAL SCIENCES

At the Department of Physiological Sciences we investigate and develop innovative solutions to health issues that pose a serious challenge to society. We follow an integrative approach that spans all levels of organisation, from the molecule to the whole organism.

RESEARCH INTERESTS

- Multi-disciplinary stress biology
- Neuro-disease signalling
- Metabolic syndrome
- Cardio-vascular diseases
- Cancer signalling mechanisms & pathways
- Muscle biology
- Clinical epidemiology & urbanisation
- Body composition
- Cardio-oncology

RESEARCH HIGHLIGHTS

Cardio-metabolic research group

Prof. Faadiel Essop

The cardio-metabolic research group (CMRG) focuses on understanding the metabolic underpinnings of various heart complications such as myocardial infarction, acute heart failure and HIV-related cardiovascular diseases. The links between diabetes and heart disease onset with a special focus on the damaging role of high sugar levels (hyperglycaemia) are also investigated.

Prof. Emmanuel Bourdon (left) with two postdoctoral fellows Dr Danzil Joseph and Dr Rudo Mapanga, and Prof. Faadiel Essop.

During 2015 the group hosted French collaborator, Prof. Emmanuel Bourdon from the University of La Réunion, for a sabbatical visit. During this time the links between the research teams were strengthened and greater focus placed on the damaging role of advanced glycation end products (AGE) in terms of the development of cardio-metabolic complications. It is well-known that AGE availability in the body can increase as a result of hyperglycaemia, oxidative stress and poor dietary choices. The latest research by the cardio-metabolic research group established that high AGE

availability within the context of a heart attack can result in greater cardiac damage. AGEs therefore emerges as a key therapeutic target to treat ischemic heart disease in especially diabetics. This exciting work forms part of ongoing research pursued in our laboratory.

Members of the CMRG team also established a novel mouse model of *ex vivo* acute heart failure. This unique experimental system allowed investigation of various therapies for acute heart failure. Here, work done by MSc student Ms Emilene Breedt revealed that the anti-anginal drug, Trimetazidine, offers therapeutic benefit in diabetic mice subjected to acute heart failure.

The clinical study on HIV and cardio-metabolic complications onset in the Cape Winelands region was strengthened by collaborations with Profs. Hans Strijdom and Quinette Louw at the Faculty of Medicine and Health Sciences at SU. So far we have established that HIV-positive individuals on anti-retroviral treatment recover quite well (no obvious damaging side-effects) but that some residual inflammation still persists. Current work is focused on trying to establish the nature and extent of this process and its potential links to the development of cardiovascular diseases.

Cancer research group

Prof. Anna-Mart Engelbrecht

The specific focus of our research is to explore new avenues of chemotherapy and adjuvant treatments that would favour the use of lower chemotherapy concentrations with less side-effect to normal healthy cells, while maintaining satisfactory levels of cancer cell death. Cancer do not distinguish between race, gender, age or socioeconomic position; it is merciful to no-one and despite the political will driving a concerted global effort, only marginal progress has been made in the War against cancer.

One aspect which contributes to the poor progress in the management of cancer relates to the severe collateral damage associated with the current treatment strategies. Although anthracyclines such as doxorubicin has proven to be of the most successful approaches to cancer treatment, it induces various side effects such as nausea, vomiting, hematopoietic suppression and cumulative, dose-dependent cardiac toxicity. However, this is not the only challenge that researchers and clinicians are faced with; cancer cells are becoming increasingly resistant to chemotherapy-induced cell death.

Cardio-oncology research group

Dr Balindiwe Sishi

The cardio-oncology research group (CORG) investigates the side effects of chemotherapy, particularly doxorubicin, on the heart. Cardiotoxicity, defined as a range of adverse effects on the heart's function induced by therapeutic molecules, is now considered one of the most important consequences of chemotherapy, leading to an increase in morbidity and mortality of cancer survivors.

The mechanism by which doxorubicin induces cardiotoxicity remains a matter of controversy. However, oxidative stress generated during intracellular metabolism is suggested to be the main role player. Although the "oxidative stress hypothesis" is supported by the ability of several antioxidants to reduce doxorubicin toxicity *in vivo*, these results could not be reproduced in clinical trials, suggesting other mechanisms are involved. We have since found that doxorubicin not only damages

mitochondria, it also interferes with activity of a vital cellular process known as autophagy. By simply increasing the activity of autophagy through starvation before chemotherapy is introduced, it appears to provide protection for the heart and significantly improve mitochondrial health. This work was presented at the annual Physiology Society of Southern Africa (PSSA) during 2015 by Itumeleng Chabaesele. Furthermore, this work has led to two MSc- and one Honours degree.

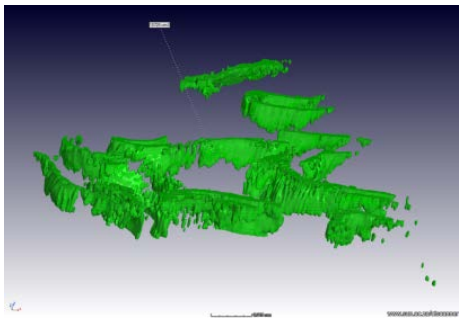
Muscle research group

Prof. Kathy Myburgh, DST South African Research Chair (SARChI) in Skeletal Muscle Physiology, Biology and Biotechnology

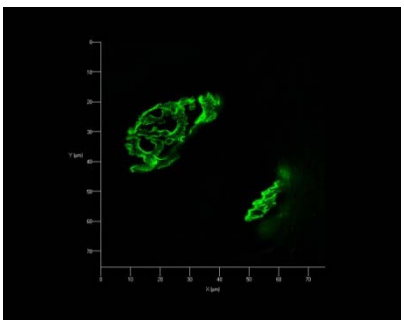
The muscle research group (MRG) focuses on skeletal muscle injury, inflammation and oxidative stress; regeneration from injury including the roles of satellite cells, myoblasts and immune cells; processes satellite cell proliferation, differentiation and fusion; specific immune cells and functions of interest include neutrophil adhesion and inhibition; macrophage phenotype; signalling pathways of interest; and exercise physiology.

The biotechnology aspect of the group's research has developed substantially in terms of technical aspects e.g. exosome micro-vesicle isolation and analysis. Exosomes are less than 120 nm in diameter but carry important biological information in the extracellular space and circulation. Very little is known about the influence of exercise on exosome release by muscle and possible uptake by muscles distant from those that were the primary exercisers. An exciting collaboration was launched with Dr Karin Ekström from the Biomaterials Group at Gothenburg University in Sweden. She was the first to identify that exosomes carry mRNA and that this mRNA can be taken up by cells very distant from the source.

Postdoctoral fellow Dr Peter Durcan will spend two months at Genethon outside Paris where he will learn to master techniques to manipulate the expression of splice variants of a fusion gene named Kirrel. This will be done in cultured muscle cells, but the application is that one would like to be able to influence stem cell therapy for muscle injury or myopathy.



NMJ 2-D:



NMJ 3-D:

The Confocal Microscope in the Central Analytical Facility's Microscopy Unit enabled students to visualise neuromuscular junctions in 2-D and in 3-D.

Multi-disciplinary Stress Biology

Prof. C Smith

Epigenetics – at the forefront of technology in stress-related research

Through collaboration with a researcher from the UK, our group has expanded our research on the effects of chronic inflammation to epigenetic level. PhD student Monet Viljoen recently completed her studies, which investigated the role of anxiety in clinical outcome after trauma exposure in schoolchildren and which spanned the disciplines of stress endocrinology, immunology and psychiatry. She successfully showed that anxiety proneness may be even more harmful than trauma exposure in terms of clinical immunological outcome and linked physiological outcomes to central psychiatric measures – the implication of these data is that previous studies on trauma in children may have to be revisited, since this confounder may have skewed the outcome and thus interpretation of these research studies. In addition, Ms Viljoen's data indicates the possibility of a new biomarker to be implemented in this population, which is currently investigated further. In addition, DNA extracted from collected white blood cells were analysed for epigenetic modifications associated with inflammation, glucocorticoid sensitivity in the context of anxiety and trauma. As result of this research, Prof. Carine Smith was invited to deliver a plenary lecture at the Physiology 2015 conference, held in Cardiff, Wales, in July 2015. Currently, our group is investigating how these changes may be maintained and transferred transgenerationally, using models in chronic inflammation in mice.

Plant medicine – rigorous testing pays off for the consumer

Prof. C Smith

One focus of our group is the unbiased testing of plant medicines. In 2015, our group has received relatively large media coverage for two different studies:

Firstly, in South Africa, *Sutherlandia frutescens* is widely known for its anti-stress effect, the scientific proof of which was first reported by our group more than a decade ago. Because the plant has also been shown to reduce muscle wasting in the chronically ill, HIV patients were encouraged by clinic staff to use this plant as supplement.

Research has shown that the HI-virus initiates chronic inflammation of the central nervous system soon after an individual becomes infected. Neuro-inflammation promotes the development of neurodegeneration and dementia, and this process is already in progress before the roll-out of anti-retroviral (ARV) therapy in HIV+ individuals. The ideal therefore would be to a supplement to limit the extent of neuro-inflammation, especially as ARV drugs have not been designed for this purpose. We thus investigated the potential of *Sutherlandia* in the context of neuroinflammation. However, our data, obtained in a validated cell co-culture simulation of the human blood-brain barrier, support earlier work of the beneficial action of *Sutherlandia* but only in non-HIV conditions. In the HIV+ condition, the HIV-induced secretion of inflammatory cytokines and pro-inflammatory immune cell infiltration across the blood-brain barrier was exacerbated, cautioning against the use of *Sutherlandia frutescens* at any stage post HIV-infection. In contrast, we have shown very positive effects for a South African-maunfactured grape seed polyphenol in this context. Two scientific papers and several lay publications appeared on this topic in 2015.

Secondly, our group investigated central effects of the natural anti-depressant prepared from *Sceletium tortuosum*. For years, it has been commonly accepted that *Sceletium* extract acts as selective

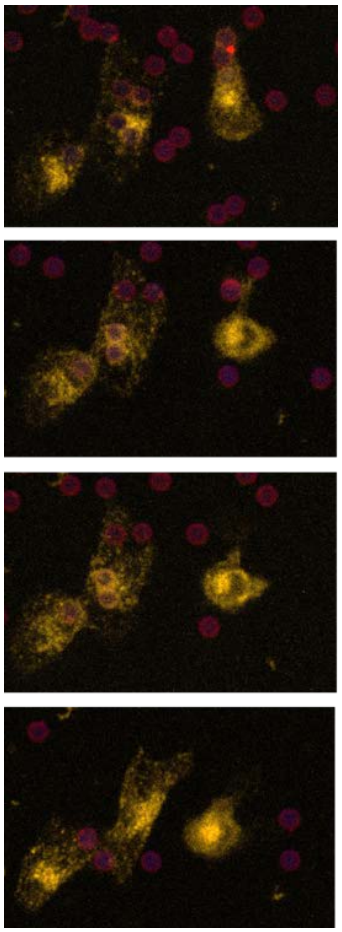
serotonin reuptake inhibitor – a mechanism used in many pharmaceuticals used for the treatment of depression. We were able to show – by using a more comprehensive approach – that this SSRI function is only half the truth. Our data points to a primary action of *Sceletium* extract to release serotonin, while the reuptake inhibition is a secondary action. Although both may alleviate symptoms of depression, there are large differences in terms of risk to consumers, drug-dependency, etc. Our data will thus contribute hugely to the process of identification of the most appropriate consumer population as well as dosages to be used.

Our research on plant medicines by no means argue against the use of these plant medicines as originally prescribed by indigenous knowledge practitioners – rather, we aim to distinguish between populations and conditions that would most benefit from a specific plant and those who would do better to avoid talking it at all.

Blue Skies funding for macrophage/cellular 'taxis'

Prof. C Smith

This three-year project is funded by the Blue Skies funding initiative of South Africa's National Research Foundation – after a seed funded year in 2014 produced sufficient proof of progress, this project received full funding for 2015-2017. This research funding instrument supports "multi-dimensional, self-initiated, curiosity-driven inquiry that necessitates high investment risks, addresses new phenomena and push the frontiers of knowledge".



Our approach: We already know that our immune system manufactures large cells – called macrophages – to fight infections. These large cells literally recognise, engulf and then destroy invaders in a process we call phagocytosis (the process by which a cell engulfs material either to destroy it, to feed on it, or to get information from it). In addition, these cells are highly mobile and can efficiently cross cellular barriers to migrate from circulation into various tissues. Ours is a novel approach to exploit this process for targeted stem cell delivery in regenerative medicine – we plan to use the highly mobile macrophages as shuttle to deliver stem cells, unharmed, to regeneration sites.

From studies in 2015, our group has successfully altered the macrophages chemically to prevent the stem cells from being digested, while not compromising the motility of the cells or their ability to phagocytose stem cells. These data was presented at an international conference in January 2016.

Time-lapse images of three modified macrophages, captured using confocal microscopy in the Central Analytical Facilities unit at Stellenbosch University. The macrophage in the centre contains numerous fluorescent-red labelled latex beads (representing a stem cell) without digesting the red protein on the bead surface. At the bottom, a macrophage can be seen extending its pseudopod to grab on to two "stem cells" and ingest them. Images: Johan Visser (MSc student, Dept Physiological Science)

Epidemiology metabolic syndrome research group

Dr Theo Nell

Dr Theo Nell and postdoctoral fellow Dr Maritza Kruger collect a blood sample from a farm worker in the Winelands region. Photo: Wiida Basson

The EpiMetS research group collected data on the prevalence of the metabolic syndrome among farm workers around Stellenbosch. The focus was to establish certain health parameters and how body composition correlated to the high burden of lifestyle associated diseases.

During 2015 three MSc students and one postdoctoral fellow collected approximately 200 blood samples to classify people as having been diagnosed with the metabolic syndrome. Results indicated that female farmworkers are at high risk for the development of diseases of lifestyle and that both genders are also at a very high risk of developing cardiovascular diseases. Two publications were submitted to communicate these findings. Additionally, research findings will be presented at the 2016 Experimental Biology Conference, in San Diego, USA. This project also led to international collaboration with Prof. Derek Renshaw from Coventry University in the United Kingdom. Prof. Renshaw will visit SU during March 2016 to train postgraduate students in a novel ELISA he developed.

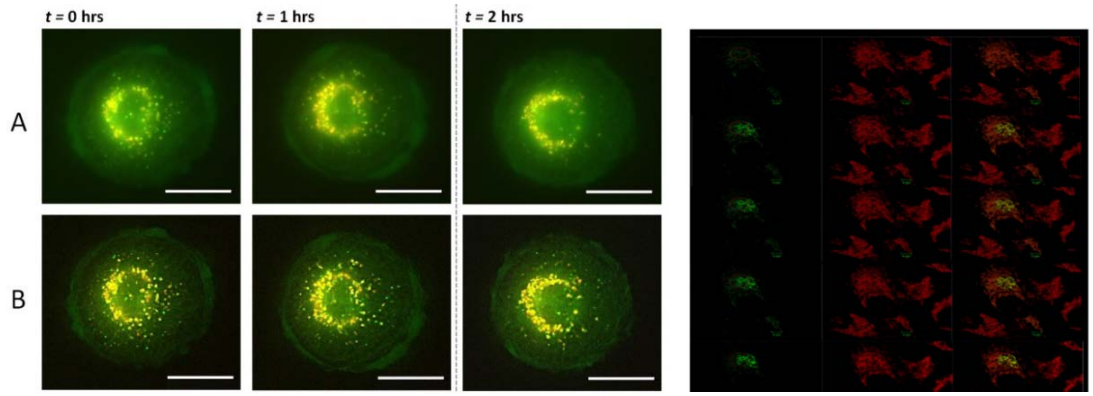
Neuro research group

Dr Ben Loos

The neuro research group (NRG) combines cell biology, cell physiology, microscopy and biochemistry approaches to dissect and investigate the relationship and role of protein degradation through macroautophagy and cell death susceptibility in neurodegeneration, neuronal migration and gliomas.

During 2015 several techniques were developed which contributed to unique results. Advances for morphometric analysis of mitochondrial dynamics and organellar pool sizes were made, both important areas in the field of single cell analysis.

Quantitative readout based on fluorescence probes can provide powerful insights into the physiology and pathology of the cell. The technique of micropatterning makes use of specialized dishes, coatings and masks, that positions a cell at a precise localization, minimizes cell migration and therefore allows precise analysis over a duration of many hours. An automated stage positioning will then drive to the same cell, allowing to gather data faster. Mitochondrial dynamics are challenging to assess. Laser-controlled photo-activation allows to photo-activate single mitochondria in a transfected cell, thereby quantifying its dynamic behavior. Both techniques can be used to evaluate cellular injury and specific metabolic properties.

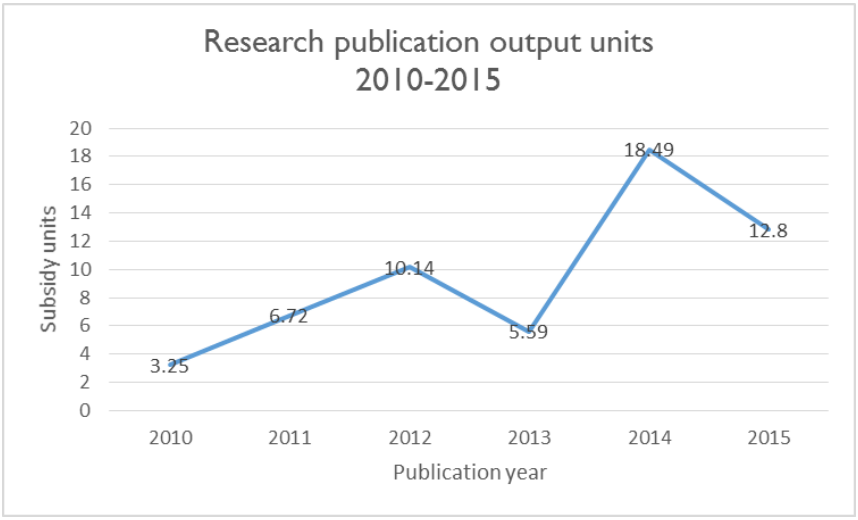


Micropatterning (left) allows to control precise cellular positioning, thereby enabling the accurate gathering of single cell derived data in time, such as organellar pool sizes. Mitochondrial photoactivation (right) indicates their dynamic behavior, enabling the quantification of their fission & fusion rate.

RESEARCH PROFILE

Research output

Over the past five years staff have published in high-impact journals such as *Autophagy* (11.753), the *Journal of Pineal Research* (9.6), the *Journal of Clinical Endocrinology Metabolism* (6.209), as well as *Biomacromolecules*, *FASEB Journal, Sports Medicine* and *Biochemical Pharmacology*. During 2015 researchers co-authored four articles in the journal of the Federation of American Societies for Experimental Biology (FASEB), widely regarded as one of the world's most cited biology journals.



In 2012, Prof. Anna-Mart Engelbrecht and Dr Ben Loos were part of a 99-page review paper, "Guidelines for the use and interpretation of assays for monitoring autophagy", published in the high-impact journal *Autophagy*. The article has since been cited 1 459 times which makes it the most highly-cited article in the Faculty of Science to date (source: SCOPUS data access 23 May 2016). In terms of alternative metrics, the paper has been mentioned by two blogs, ten Facebook pages and tweeted 50 times.

During 2015, Prof. Engelbrecht was also invited to write an editorial on the protective role of melatonin in doxorubicin-induced cardiotoxicity in a special focus issue of *Future Oncology* [11:14, 2003-2006].

Highly-cited articles (from previous five years) include:

- Loos, B.,Engelbrecht, A-M., Lockshin, RA, Klionsky, D.J.,Zakeri, z. 2013. The variability of autophagy and cell death susceptibility: Unanswered questions. *Autophagy*, 9 (9), pp. 1270-1285. Cited 41 times.
- Loos, B.,Genade, S.,Ellis, B.,Lochner,A, Engelbrecht, A-M. 2011. At the core of survival Autophagy delays the onset of both apoptotic and necrotic cell death in a model of ischemic cell injury. *Experimental Cell Research*, 317 (10), pp.1437-1453. Cited 33 times.
- Sishi, B, Loos, B., Ellis, B, Smith, W., Du Toit, E.F., Engelbrecht, A-M. 2011. Diet-induced obesity alters signalling pathways and induces atrophy and apoptosis in skeletal muscle in a prediabetic rat model (2011) *Experimental Physiology*, 96 (2), pp. 179-193. Cited 30 times.

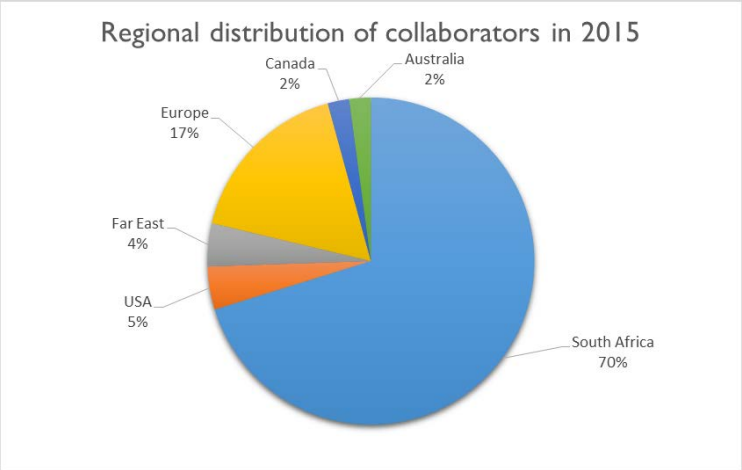
During 2015 Dr Ben Loos received a Y-1 NRF rating, which brings the number of NRF-rated researchers in the Department to five.

NRF-rated researchers

Internationally acclaimed researcher	Prof. Kathy Myburgh	skeletal muscle biology
Established researcher	Prof. Faadiel Essop	cardiac metabolism
	Prof. Carine Smith	stress biology
	Prof. Anna-Mart Engelbrecht	cell-death and signalling
	Prof. Faadiel Essop	cardiac metabolism
Promising young researcher	Dr Ben Loos	neuro-disease signalling

Collaboration

During 2015 the Department's researchers co-authored publications (research articles, book chapters and conference proceedings) with academics from more than 30 institutions from 12 different countries.



Funding

South Africa

Cancer Association of South Africa
Medical Research Council Inter-University Cape Heart Group
Medical Research Council Of South Africa
National Research Foundation, South Africa
Stellenbosch University
Technology Innovation Agency TIA

International

Canada Research Chair In Molecular Physiology
Conseil Regional de la Réunion, France, and Europe Redox Project
Coventry University, United Kingdom
European Hydration Institute
Harry Crossley Foundation
Jefferson Pilot Corporation
L Meltzer Foundation
Leducq Foundation Transatlantic Networks Of Excellence
Ministere de l'Enseignement Superieur et de la Recherche et de l'outre Mer
National Institutes of Health, USA
Natural Sciences and Engineering Research Council of Canada
Norwegian Council on Cardiovascular Diseases
Norwegian Research Council
UNC Nutrition Obesity Research Center
Université de la Réunion
University Of Bergen, Heart Foundation

Awards

MSc student Mr Itumeleng Chabaesele received the Wyndham student award for the best oral presentation in the physiological sciences during the annual conference of the Physiology Society of Southern Africa (PSSA) recently. Winning the Wyndham award is quite an achievement as postgraduate students compete against MSc and PhD students from all South African universities and has to withstand the scrutiny of a panel of ten judges. The winner also becomes eligible to be considered for a sponsored trip to the next International Union of Physiological Sciences (IUPS) Congress that will take place in Brazil in 2017.

MSc student Itumeleng Chabaesele (on the right) with his study leader, Dr Bandiliwe Siswi. Photo: Wiida Basson

MSc student Ms Emilene Breedt was awarded the runner-up prize for best poster presentation at the annual congress of the Physiology Society of Southern Africa. PhD student Jenelle Govender was selected as one of 22 finalists in SU's New Voices in Science initiative to present her work "Protecting the heart during chemotherapy" at the main event which was held at STIAS on 7 December 2015.

PhD student Jenelle Govender receiving her award during SU's Young Voices in Science competitioin.

Academic activities

Prof. Anna-Mart Engelbrecht

- Two PhD students, Jenelle Govender and Tanja Davis, attended the 20th World Congress on Advances in Oncology and the 18th International Symposium on Molecular Medicine conference in Greece from 8 to 10 October 2015. Both students, supervised by Prof. Engelbrecht, made oral presentations. Jenelle's presentation was entitled "Mitochondrial catastrophe during DXR-induced cardiotoxicity: The protective role of MLT", and the title of Tanja's presentation was "Investigating the function of the AHNAK protein in doxorubicin resistance"

Dr Ben Loos

- Invited keynote lecture at an Autophagy symposium in Seoul, South Korea
- Presented several talks that formed part of a research collaboration with Mysore University, India
- Presented a talk at a workshop on high resolution microscopy at a satellite meeting hosted by the International Mitochondrial Society

Prof. Kathy Myburgh

- Attended the launch workshop of the European Union RISE Research Consortium studying muscle stress relief, Athens, Greece, December 2015

Service to the scientific community

Dr Ben Loos

- Member of the Central Analytical Facility's academic committee (since 2012)
- Member of the Microscopy Society of Southern Africa (MSSA)
- *Life Sciences* (editor since 2013)
- Treasurer and secretary to the Physiological Society of Southern Africa [PSSA] since 2014
- Delegate of the South African National Committee of the International Union of Physiological Sciences (SANC-IUPS) (2014-17)
- National Research Foundation (NRF) panel member for Strategic Platforms Programme (since 2011)
- External examiner for the honours course in physiology at the University of KwaZulu-Natal since 2015
- External examiner of third year course modules in the Department of Physiology at the University of Pretoria since 2015
- Serves as external peer reviewer for the journals *Autophagy*, *PLOS One*, *Free Radical Research*, *Molecular and Cellular Biochemistry* and the *American Journal of Cardiology*

Dr Theo Nell

- External peer reviewer for the journals *Clinical Epidemiology*, *Nutrition and Dietary Supplements*, *Clinical Medicine Insights: Oncology*, *Journal of Diabetes and Its Complications*, *SA Journal of Sport and Recreation*, *Cardiovascular Journal of Africa*, *Metabolic Brain Disease* and *SA Journal of Clinical Nutrition*
- Serves as National Research Foundation panel member for DAAD, PHD, MSc, and postdoctoral fellows

Dr Bandiliwe Sishi

- Reviewer for the *International Journal of Nanomedicine*, *Biochemical Pharmacology*, *Turkish Journal of Biology* and the *Journal of Pharmacy and Pharmacology*
- Organises the journal club for the SU-UCT-Tygerberg branches
- Organises departmental seminars together with Dr Nell
- National Research Foundation panel member

Social impact

The Department's postgraduate student society (PPSS) were involved in the Siyaphambili Orphanage in Kayalitsha. They collected clothes and educational tools to donate to the house, painted the houses and played Secret Santa. They also paid the orphanage's electricity for the past three years.

Dr Sishi took part in the Faculty of Science's recruitment drive from 20 to 23 May 2015 at schools in Port Elizabeth, East London, Uitenhage and Grahamstown in the Eastern Cape.

The EpiMetS research group hosted health talks on topics related to public health, including high blood pressure, healthy eating habits, stroke, cancer and the metabolic syndrome to three farm-working communities around the Stellenbosch region. The Department is also involved in the Faculty of Science's annual Maties Science Winter Week and several of our staff serve as judges for the regionals of the ESKOM Expo for Young Scientists.

ACADEMIC AFFAIRS

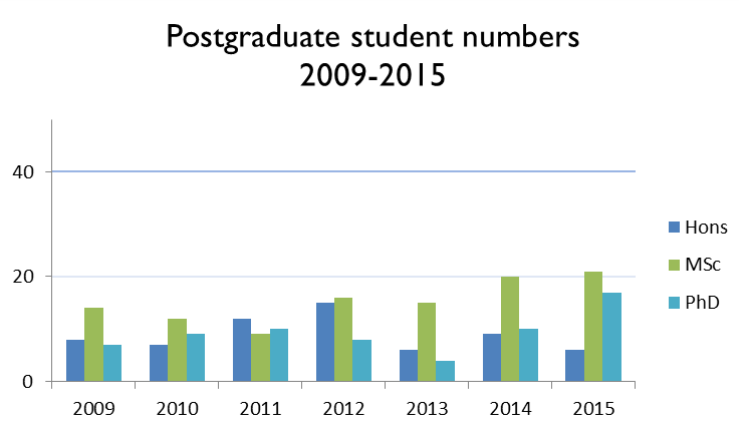
Teaching and learning

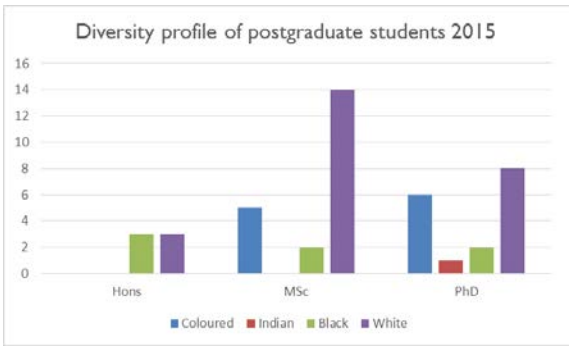
During 2015 the Chief Executive Officer of the Heart and Stroke Foundation presented a talk to third year physiology students on invitation of Prof. Faadiel Essop. The Heart and Stroke Foundation works closely with researchers like Prof. Essop to provide science-based evidence on which the foundation can base their recommendations. There is, however, a dearth of information about the South African population.

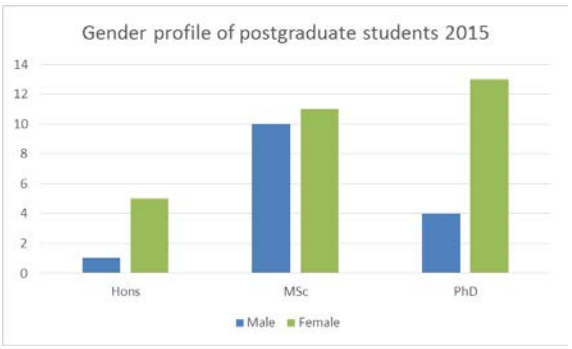
Third year physiology students with Dr Vash Mungal-Singh, CEO of the Heart and Stroke Foundation of South Africa, and Prof. Faadiel Essop, head of the Department of Physiological Sciences, in the middle. Photo: Wiida Basson

Focus on postgraduate students

During 2015 four MSc and one PhD student graduated. Since 2013, there has been a steady increase in especially the number of MSc and PhD students. The Department is also home to five postdoctoral fellows: they are Dr A Brand, Dr P Durcan, Dr D Joseph, Dr M Kruger (South Africa) and Dr R Mapanga.







Staff list

Academic staff

Prof. A-M Engelbrecht (Departmental chair)
Prof. MF Essop
Dr B Loos
Prof. KH Myburgh
Dr T Nell
Dr B Sishi
Prof. C Smith
Dr JA de Wet Strauss

Technical and support staff

Dr A Krygsman
Dr L Lacerda
Mr A Isaacs
Ms GA Simon

PUBLICATION LIST 2015

DEPARTMENT OF BIOCHEMISTRY

Journal articles (subsidised)

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