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Physics Comment

A Southern African Physics Magazine

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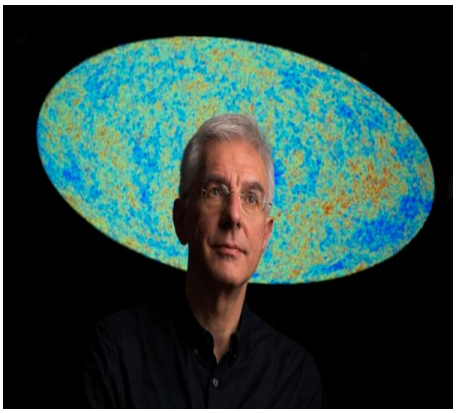

Tributes to Professor Dave Walker, Professor Sergio Colafrancesco and Professor Max Michaelis (Page 6 - 11)

Editors: Professor Deena Naidoo, Dr Hellen Chuma and Dr Buyi Sondezi

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Editor's Note

This edition of the PC Magazine reports on the sad loss of three distinguished researchers, Professor David Walker (Theoretical Physics – University of KwaZulu-Natal), Professor Sergio Colafranscesco (Radio Astronomy and Astrophysics – University of the Witwatersrand) and Professor Max Michaelis (Laser and Optics - formerly the University of Natal).

Some highlights to note include:

(a) the SA-CERN 10 year celebrations held at the iThemba Laboratory for Accelerator-Based Sciences (iThemba LABS) in Cape Town, from 19 to 21 November 2018. The anniversary event was attended by the French and Swiss Ambassadors to South Africa, the Vice-Chancellors of the Universities of Cape Town and the Witwatersrand, and a number of internationally renowned physicists including members of the SA-CERN Programme and postgraduate students.

(b) The International Conference on Physics Education (ICPE-SAIP-WITS) co-hosted by the South African Institute of Physics (SAIP) and the School of Physics, University of the Witwatersrand (WITS) jointly with The International Commission on Physics Education (C14) of the International Union of Pure and Applied Physics (IUPAP) was held at the Misty Hills Hotel and Conference Centre, Johannesburg during the period 1-5 October 2018 attracted researchers, postgraduate students, government officials and teachers from around the world.

(c) the awarding of the South African Physics Olympiad (SAPhO) medals to talented scholars students which is one initiative to identify, nurture, monitor and mentor young people with the potential to excel in Science Engineering and Technology careers.

With best wishes for the festive season from the editorial Team.

Prof. Deena Naidoo

Dr Hellen Chuma

Dr Buyi Sondezi

Physics Comment is a magazine published by the South African Institute of Physics (SAIP) and appears quarterly . The vision of the SAIP is to be the voice of Physics in South Africa.

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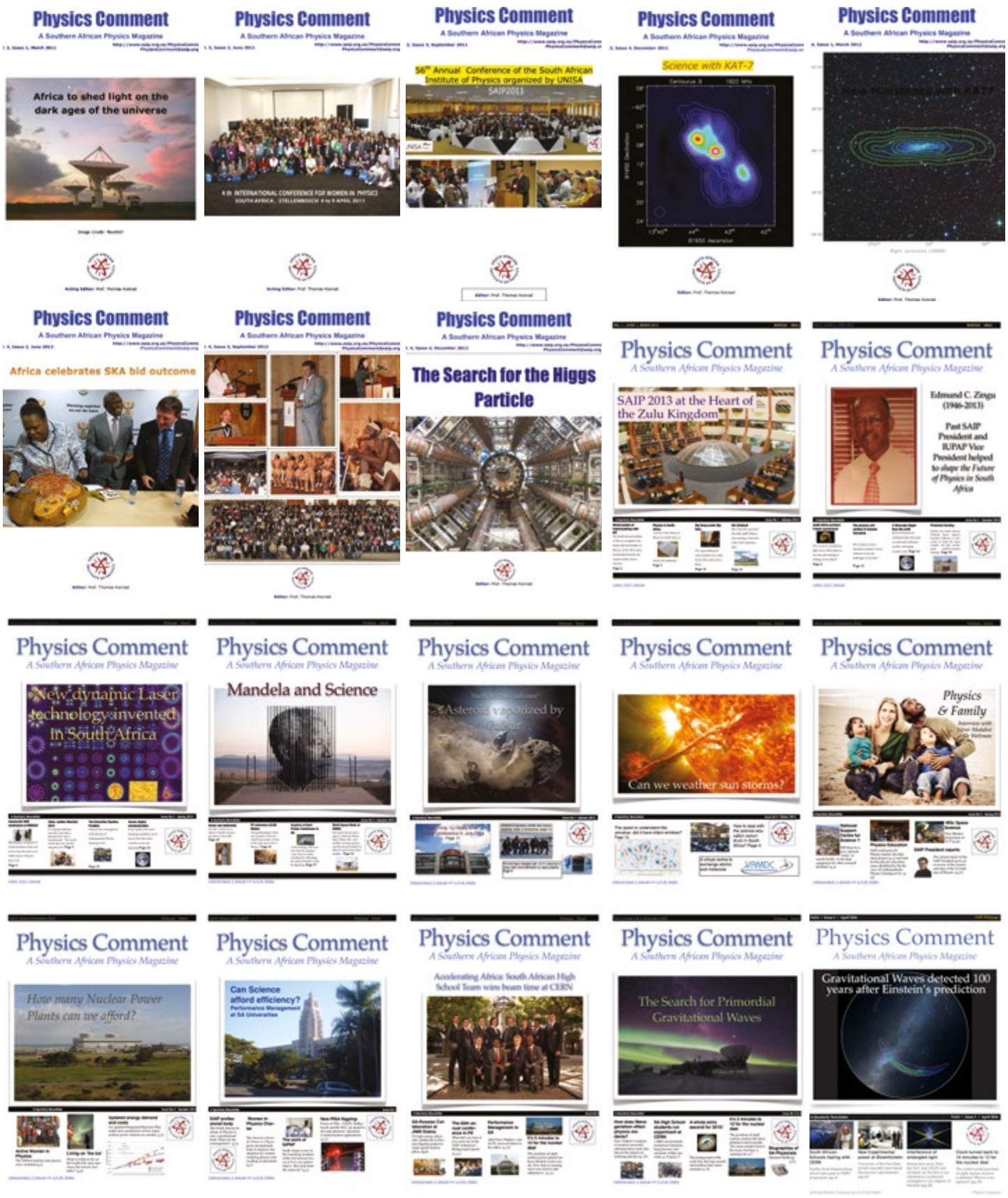

Physics Comment

A Southern African Physics Magazine

2011 - 2018

President's Corner: Message from Professor Patrick Woudt on behalf of the Council of SAIP

As the year draws to a close, it is time to look back on an exciting and successful year for physics in South Africa. Since the previous edition of Physics Comment, the physics community in South Africa celebrated the 10 year anniversary of the SA-CERN program, South Africa hosted a very successful International Conference on Physics Education under the auspices of Commission 14 of the International Union of Pure and Applied Physics (IUPAP), and the first images from the MeerKAT telescope launched in July of this year are making a global impact.

The celebration of ten years of SA-CERN collaboration in November 2018 marked a wonderful milestone in this special relation. In the presence of the ambassadors of France and Switzerland, the vice-chancellors of participating universities, the deputy director-general of DST and the deputy CEO of the NRF, the director of iThemba LABS, Dr Faical Azaiez, reflected on the success of this program and outlined his vision for the future of iThemba LABS.

Personal reflections by Dr Zinhle Buthelezi and Prof Zeblon Vilakazi emphasized the tremendous impact of the SA-CERN program on South African physicists over the past decade. The South African Institute of Physics, together with the School of Physics of the University of Witwatersrand, and the International Commission on Physics Education (C14) of IUPAP, hosted the 2018 International Conference on Physics Education at the Misty Hills Hotel and Conference Centre near Johannesburg in October under the leadership of Prof Deena Naidoo (vice-chair of C14 of IUPAP). The theme of the conference - Physics Education for Development: A Focus on Context - provided an excellent platform for an exciting week of discussions and workshops. Congratulations to Prof Naidoo and his team for hosting a very successful conference.

At the 30th General Assembly of the International Astronomical Union (IAU) in Vienna in August, South Africa presented a successful bid to host the 2024 General Assembly of the IAU.

It was a distinct privilege to be part of the team making the presentation and bringing the General Assembly of the IAU to Africa for the first time. Cape Town will be the host city in August 2024 and the CTICC will be the host venue.

The South African stand at the 30th IAU General Assembly prominently featured the first light image of MeerKAT. This image demonstrates the power of the MeerKAT radio telescope array, as it shows the centre of the Milky Way galaxy in unsurpassed detail – the fullarticle can be found under the articles section in this edition of Physics Comment.

Over the past few months the SAIP community had to say goodbye to a number of dear colleagues who made a distinct and distinguished impact on physics in South Africa.

It is with great sadness that we were informed of the passing of Prof Dave Walker, Prof Sergio Colafrancesco and Prof Max Michaelis. They shaped much of the development of physics in South Africa in their respective disciplines.

Prof Walker also served on the editorial team of Physics Comment for many years (see Physics Comment of November 2017). This edition of Physics Comment reflects on their contributions to physics in South Africa.

At the end of the year I want to thank all the volunteers who have helped the South African Institute of Physics in running a broad range of activities across the country through our hub and spoke model. A special thank you to all the reviewers of the manuscripts submitted to the SAIP conference proceeding. The proceedings mark an important window into the state of physics research in South Africa, and the reviewers and the members of the editorial team are doing an excellent job in ensuring the timely publication of the proceedings. Finally a special thank you to the members of the SAIP office and the editorial team of the Physics Comment, for keeping you connected with all the activities of the SAIP.

I wish you all a restful festive season and all the best for the new year.

Tribute to Professor Dave Walker

By Professor Manfred Hellberg

Professor ADM (David) Walker, one of our most distinguished scientists, died on 17 September, 2018, aged 80. He was Professor of Theoretical Physics in the University of Natal, Durban from 1972 (and Senior Professor from 1989) until he retired in 2002. After retirement, he continued as an active researcher until the end, as Emeritus Professor and Senior Research Associate of the University. After undergoing surgery in June, he unfortunately never really recovered. He will be missed by many, by his colleagues and students, and by the wider space science community, both nationally and internationally. After matriculating at Umtata High School, Walker went to Rhodes University, where he had the good fortune to come under the influence of two top scientists: Profs JA Gledhill (Physics) and D Burnett (Applied Mathematics).

Burnett's work on the kinetic theory of non-uniform gases, published in the 1930's in Proc. London Mathematical Society, is still cited 8 decades later. On the other hand, Jack Gledhill, a polymath, is regarded by many as being the father of space physics in South Africa. After his BSc (Hons) (1959) he was employed as a Junior Lecturer and Lecturer at Rhodes (1960-62), while doing an MSc on "Solar eclipses and the ionosphere" with Gledhill. This work led to a joint publication, as well as a single-author paper in Nature. With a Shell International Postgraduate Scholarship he went to St. John's College, Cambridge, and did research under Dr Kenneth Budden (FRS, 1966) at the Cavendish Laboratory. His PhD thesis (1966) was entitled "Radio waves in the ionosphere and exosphere". This led to 3 further single-author papers in leading journals, on the theory of radio propagation. After returning to Rhodes he was promoted to Senior Lecturer, before his move to Durban in 1972.

David Walker was recognized internationally as a world leader in space physics. After his early research on radio propagation and ray tracing, particularly of VLF waves, much of his later work centred on ULF geomagnetic pulsations, hydromagnetic waves in the magnetosphere, and magnetospheric phenomena. In addition to carrying out sophisticated theoretical calculations, he was also involved in the analysis and interpretation of both ground-based and satellite observations of space plasma behaviour. The 1979 paper by Walker, Greenwald, et al. is a classic and has been cited 260 times. Applying his theoretical prowess to data from STARE (Scandinavian twin auroral radar experiment), they provided complete understanding of the origin of long period (Pc5) geomagnetic pulsations from hydromagnetic field line resonances. He was a co-initiator of and a PI from 1993 to 2002 on the international SHARE (Southern Hemisphere Auroral Radar Experiment) project that involved dual radars at the South African Antarctic base (SANAE) and the British base (Halley Bay). As such he was also for many years a senior member of the international SuperDARN community working on auroral radar experiments.

When the FRD, forerunner of the NRF, introduced rating based on international peer evaluation in 1984, he was one of the first group of about a dozen scientists across all disciplines to earn an A-rating. Despite University, national and international management roles, he retained his A-rating throughout successive re-evaluations to his retirement in 2002, after which it dropped to a B-rating. He was also the first chairman of the FRD Physics Evaluation committee (1984-90), and member of the Main Awards Committee (1984–88) and of the FRD Collegium (1988-90). David received many accolades. In 1998, SAIP awarded him its highest honour, the SAIP de Beers Gold Medal, for outstanding achievements in Physics, and he was elected a Fellow of SAIP when that category was introduced in 2012. He was also a Fellow of the Institute of Physics (London) (1976-85), the Royal Society of SA (1988 --) and the University of Natal/UKZN (1989 --), and a Founder Member of the Academy of Science of SA (1994 --).

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Internationally, too, his research and his views were highly regarded. Dave was elected Vice-President of the ICSU Scientific Committee for Antarctic Research (SCAR) in 1998-2002 and Chairman of the Solar Terrestrial and Astrophysical Research Working Group of SCAR (1994-2000). He also served on the Editorial Advisory Board of Planetary and Space Science (1982-92), and in 1999 he received an Editor's Award for excellence in refereeing from the prime journal, J Geophysical Research - Space Physics (American Geophysical Union), before becoming an Associate Editor (2000-2002).

Walker published 85 peer reviewed research articles, many of them single-authored, and his work has been cited more than 3000 times. His last 3 papers were published in 2016, but ongoing projects should lead to further articles. In addition, he had 79 papers at international and 56 papers at national conferences. Unusually, for a physicist, he also wrote 2 major research books: Plasma Waves in the Magnetosphere (348 pages), Springer, 1993, and Magnetohydrodynamic Waves in Geospace: The Theory of ULF Waves and their Interaction with Energetic Particles in the Solar-Terrestrial Environment (550 pages), IoP Press, 2004. He graduated 8 PhD and 10 MSc students; a final student submitted his Masters' thesis recently.

Dave Walker was a consummate all-round academic. Apart from being a world-class researcher, he took his teaching seriously. When he joined the University of Natal, he brought with him a fresh look at our teaching and had a significant impact, for instance, in the development of lecture demonstrations and in supporting teaching experiments. His lectures were of a very high standard and were known for their clarity, his depth of understanding of physics, and his well-planned notes. During his career, he filled various management roles at the University of Natal, including Head of Department for 16 years, Dean of Science, part-time Pro-Vice Principal (Information Systems) for 2 years, and three short spells as Acting Vice-Principal, as well as being elected to serve on Council, and on numerous committees of Senate. He also chaired the Trustees of the University Retirement Fund. After retiring, he held part-time posts as Pro-Vice-Chancellor (Research) (2003-04) and as Director of Special Programmes in the UKZN Research Office (2005-06). These entailed working on a variety of projects, including the merging of the 3 independent and 16 branch libraries, and the setting up of a Research Ethics Guide and protocols for the new, merged institution. His academic leadership style was characterized by his friendliness, his analytical, incisive mind, his integrity and fairness, his ability to delegate and his decisiveness. As a retired colleague has written, "It was a pleasure to be a member of the Physics Department he led so superbly - many happy memories!" Dave had a way with words.

The numerous documents that he prepared in his management roles were extremely well written, well-documented, analytical, and to the point. He was also an excellent speaker, whether as a debater in Senate, or as an entertaining after-dinner speaker. He was extremely well-read, and that feature was invariably reflected in his writing and his speeches.

After completing his second research monograph, Walker embarked on serious historical research, scouring museums and archives, following the story of his forebears, who were 1820 Settlers. This led to a 492-page book entitled Pawns in a Larger Game: Life on the Eastern Cape Frontier in 2013. His other hobbies included gardening and water colour painting. At one stage he took up long distance running, and twice qualified for the Comrades Marathon, but to his regret did not finish.

During his Cambridge days, Dave met Carol Glencross, a Scottish statistician, and they married in 1967. Carol was very supportive of him throughout his career, and his family played an important part in his life. Their 3 children now live in New York, Cape Town and Glasgow, and they have 6 grandchildren. Our heartfelt condolences go to Carol and the family at this sad time.

Editor's Note: An autobiographical article by Dave Walker appeared in Physics Comment in December, 2013.

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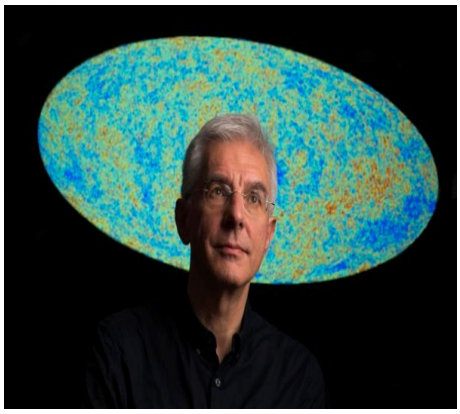
Tribute to Professor Sergio Colafrancesco

By the School of Physics, WITS University and the SAIP Office



It is with great sadness that the University of Witwatersrand announces the passing of Professor Sergio Colafrancesco, a scientist and member of the School of Physics. Professor Colafrancesco passed away on Sunday, 30 September 2018, following a battle with cancer.

He was the DST-NRF Square Kilometre Array (SKA) Research Chair in Radio Astronomy in the School of Physics. His appointment heralded the beginning of distinguished research activity in Radio Astronomy and Astrophysics at Wits and the eventual establishment of a research group currently comprising five academics in the School.

The Chair is of local and international significance and provides closer alignment with the SKA project. It was established to contribute to the understanding of the structure, origin and evolution of the Universe and of its sub-structures, from the smallest galaxies to the largest galaxy clusters. Professor Colafrancesco was involved in a number of ground-breaking projects that showcased the country's leadership and competitiveness in science. He was a highly cited, internationally recognised expert in cosmology and astrophysics.

The South African Institute of Physics conveys its deepest sympathies. As an active and distinguished member of the SAIP, Prof Colafrancesco made tremendous contributions to the development of radio and gamma-ray astronomy in South Africa and further afield on the African continent. "His passing at a time when MeerKAT comes online is heart-breaking," says Professor Patrick Woudt, President of the Institute and Head of Astronomy at UCT.

Born in Italy, Colafrancesco joined Wits in August 2011 from the University of Rome where he was a professor of astrophysics. Prior to that, he was a senior scientist with the Italian Institute for Astrophysics. He obtained his PhD in Astronomy at the University of Padua, Italy.

The University of Witwatersrand and the SAIP offers its deepest condolences to the family, friends and colleagues of Colafrancesco.

Details of his memorial service will be shared once available.

Tribute to Professor Max Michaelis

By Professors Andrew Forbes and Manfred Hellberg

It is with sadness that we received the news of the death of our former colleague, Emeritus Prof. Max Michaelis, at his home near Oxford, England on 4th June, 2018, aged 81. Appointed as a Lecturer in Physics on the Howard College campus of the then University of Natal in 1976, he rose through the ranks, being promoted to ad hominem Professor in 1994. After an extension beyond normal retirement age, he retired at the end of 2000, returning to his home in Oxfordshire. Prof Michaelis held a D.Phil. from Oxford.

After his doctorate he carried out high-power laser ablation and acceleration studies of metal foils at the UKAEA Culham Laboratory for fusion research, before joining our University. Historically, his family had strong ties with South Africa – his grandfather, Sir Max Michaelis, benefactor of the Michaelis art collection and the Michaelis School of Art in Cape Town, was one of the Randlords who helped develop South Africa's diamond and gold industries.

After joining the University, Max Michaelis established a laser laboratory and built up an active postgraduate group in lasers and optics. His research encompassed a variety of topics, including laser ablation and laser-matter interaction, but he is probably best-known for his multi-facetted work on hot gas lenses, based on a concept related to the physics of mirages. In his later years he developed a collaboration with Reunion University that involved lidar studies of aerosols in the upper atmosphere. Whereas his laser laboratory was unfortunately closed down following the merger, the lidar studies have been resuscitated and are ongoing.

Max Michaelis was known for his many innovative and even outlandish ideas. For Max, conventional was boring, preferring to dream of the world that could be. His speculations spanned anti-matter, space travel, laser propulsion, lenses made of flames and vacuum tunnels across continents. Never shy to share his views, he even formally proposed to the then Minister of Science the notion of Mount Kilimanjaro as an ideal laser-propulsion satellite launch centre, suggesting that perhaps the dormant volcano could be used as an energy source. Max kept a journal referee letter pinned to his board, which read: "I abhor speculative ideas and yours, sir, are speculative to the highest order." He took this as a compliment; it was how he thought scientists ought to think. Many of his eccentric ideas became a reality, with his work published in the most prestigious physics journals (cover of Nature) and attracting admiration from a wide community. He published regularly, developed numerous national and international linkages, and in 1994 was awarded a B Rating ("enjoys considerable international recognition") by the NRF. He continued to be active long after retirement, with the last of his 58 journal articles appearing in November 2015.

Prof Max Michaelis will certainly be missed by the photonics community in South Africa, where he was considered somewhat of a father figure. Many of the active groups today can trace their roots back to him. His enthusiasm for science and his daring approach to research left a telling mark on many who followed him. His contribution extended beyond just the science: he also argued strongly for a central loan facility to be set up to support laser activities in universities, as vital tools of technology in a variety of fields. His proposal was endorsed and led to the highly successful NLC-NRF Rental Pool Facility.

A characteristic of Max Michaelis's research activity was his love of "playing" with equipment, and with recognizing the deep basis and educational value of some physics toys. About 30 years ago he marketed a set of small but strong SmCo permanent magnets as an educational toy, to study physical phenomena. He called them Maxnets (a recent third-party YouTube clip illustrates their use and laments their no longer being on the market). And during the last decade he published a number of articles in physics education journals about the science underlying aspects of the Levitron, another physics toy, and the inverted pendulum, as models of more sophisticated physical phenomena.

As a personality, Max Michaelis was a thorough gentleman, urbane, a great colleague, a fun person to have around, with a naughty sense of humour. He was widely educated, was fluent in French, German and Russian, enjoyed astronomy, art and music, and even sometimes played the harmonica at social gatherings. He was always delighted to share his excitement about physics with lay people and schoolchildren. In his youth he was a passionate skier and water-skier, and he continued to enjoy skiing.
As a physicist and teacher, he is best described by a former student: "Max was such an inspiration to me as a budding physicist with his infectious enthusiasm for the world around him and how it works. I always admired his somewhat unconventional approach to experimental physics."

Prof Max Michaelis was unforgettable, larger than life, in many ways a legend. We extend our heartfelt condolences to his wife and family.

International Conference on Physics Education

By Professor Deena Naidoo (Chair)

The International Conference on Physics Education (ICPE-SAIP-WITS) co-hosted by the South African Institute of Physics (SAIP) and the School of Physics, University of the Witwatersrand (WITS) jointly with The International Commission on Physics Education (C14) of the International Union of Pure and Applied Physics (IUPAP) was held at the Misty Hills Hotel and Conference Centre, Johannesburg during the period 1-5 October 2018.

ICPE-SAIP-WITS 2018 Conference Group Photograph.

The main theme of the conference was: "Physics Education for Development: a focus on context" with a wide range of subthemes that covered areas of Physics Education spanning: Physics at University, Physics at Primary and Secondary School Level, Curriculum: Design, Development and Delivery, Teaching and Learning of Physics Concepts, Teaching and Learning of Laboratory based Physics, ICT and Multimedia Revolution in Physics Education, Assessment and Evaluation of Teaching and Learning in Physics, Teacher Education and Training in Physics, Physics and Interdisciplinary Issues, Physics in an Informal and Non-Formal Environment and International Networks and Collaboration in Physics Education.

The scientific program comprised of a diverse range of international high-level presentations consisting of 8 plenary talks (5 women and 3 male), 120 single oral talks and 40 posters. The conference was attended by 125 delegates that included physics educators, postgraduate students, teachers, researchers and policy makers working in physics educational research and in physics education from all parts of the world.

The most important aspect of the conference was the easy interaction of delegates, sharing of information and ideas and networking which has led to collaborations. In summary delegates enjoyed the atmosphere of the conference venue, what South Africa has to offer ranging from food to our culture, the scientific conference programme and all the social events, which were scheduled as off-site conference events to the Origins Centre and the Evolutionary Science Institute (Wits University), Lion and Safari Park and Lesedi Village.

The following guest speakers delivered speeches at the conference: Professors Roberto Nardi (Chair IUPAP-C14), Patrick Woudt (President of the SAIP) and Zeblon Vilakazi (DVC Research, WITS University).

ICPE-SAIP-WITS 2018 Main Conference Venue: Pelindaba.

Guest Speakers at ICPE-SAIP-WITS 2018: Professors Roberto Nardi (Chair IUPAP-C14), Patrick Woudt (President of the SAIP) and Zeblon Vilakazi (DVC Research, WITS University).

Conference Highlights & Visit to Wits University

Professor Diane Grayson delivering a plenary talk in the ORIGINS Centre, WITS University.

Delegates enjoying the different sites at WITS University.

Visit to the Lion and Safari Park and Lesedi Village

Feeding of the Lions (above) with prime views for delegates and Lesedi Cultural Dancers (below).

All conference photographs can be viewed at: http://events.saip.org.za/conferenceDisplay.py?confId=93.

Ten Years of SA-CERN

By National Research Foundation sourced from the University of Witwatersrand Website

Collaboration on Fundamental Physics celebrates a decade, of among others, Wits' involvement in accelerated technology development

The 10-year celebration of the partnership between the South African physics community and CERN, the European Organisation for Nuclear Research, is being celebrated at the iThemba Laboratory for Accelerator-Based Sciences (iThemba LABS) in Cape Town, from 19 to 21 November 2018. The event attracted a full house on its first day, with the French and Swiss Ambassadors to South Africa, the Vice-Chancellors of the Universities of Cape Town and the Witwatersrand, and a number of internationally renowned physicists attending.

SA-CERN Ten Year Celebration: Group Photograph.

IThemba LABS, a research facility funded by the Department of Science and Technology through the National Research Foundation, employs senior scientists dedicated to the SA-CERN programme and offers world-class infrastructure and administrative support. The research programme in fundamental physics at CERN's Large Hadron Collider (LHC) has brought many opportunities for South Africa's science community.

Founder of the SA-CERN Programme, Prof. Zeblon Vilakazi, said the partnership received support at the highest levels, with a recent visit from the Minister of Science and Technology, Mmamoloko Kubayi-Ngubane. Professor Vilakazi said that, since the launch of the programme, South Africa had established a solid presence at CERN. Over the past decade, SA researchers have contributed to major breakthroughs at the global facility, including the historical discovery of the Higgs boson particle in 2012.

Dr Zinhle Buthelezi, a Senior Researcher at iThemba LABS, who benefited from the collaboration at postgraduate level, said that the experience had been life-changing, and praised the Department of Science and Technology for funding the SA-CERN initiative. She also welcomed the Department's expansion of the initiative to include software and hardware engineering, which holds huge benefits for local students.

The Department's Deputy Director-General: Research Development and Support, Dr Thomas Auf der Heyde, said that the initiative has contributed significantly to the growth of the physics community in South Africa. South African papers in the sub-fields of nuclear, particle and field physics increased to between 2,5 and 3 times the global average, while the overall standing of work in applied, fluid, plasma, atomic and mathematical physics remained unchanged. Racial demographics have also improved, although gender representivity remains skewed in favour of men, with only 12% of publications attributed to women. Dr Auf der Heyde said that the partnership between CERN and South Africa, as well as between South Africa and the Joint Institute for Nuclear Research in Russia, had contributed to strengthening nuclear-related physics in South Africa.

The partnership with CERN has also accelerated technology development, enhancing both technological and social innovation, and providing advanced scientific training for new generations of scientists and science managers. Partnerships around global infrastructures such as CERN allow South African research to benchmark itself against its global partners and rivals, thereby establishing an objective perspective on its standing in the global world of science. The human capital development aspect of the collaboration has also been significant. Currently, about 29 senior researchers, 13 postdoctoral fellows and 50 master's and doctoral students from South Africa participate in two LHC experiments, namely, on ALICE (A Large Ion Collider Experiment) and ATLAS (A Toroidal LHC Apparatus). Several participate in the research activities at the radioactive ion beam facility ISOLDE (Isotope Separator On-Line Device). South Africa also has seven senior researchers, two postdoctoral fellows, and 12 MSc and PhD students that collaborate with the LHC Theory Group. Over the past three years, the total number of postgraduate students has increased from about 30 to over 50, and is expected to grow to more than 80 in the next few years.

The master's and doctoral degrees are of the highest international standing and all students who have graduated so far have been able to find employment in South African universities and research councils, as well as various private sector institutions (including some in the financial services sector). Owing to the CERN collaboration, there have been instances where South Africa has retained skilled scientists that might otherwise have been lost to the African Science Diaspora. Black student representation is expected to increase from 35% in 2014 to 65% in 2019, and women representation is expected to increase from 30% in 2013 to 50% in 2019. These targets are further supported by an aggressive science awareness campaign that will showcase the SA-CERN programme at previously disadvantaged universities. Dr Auf der Heyde said that there were ongoing discussions with the National Research Foundation about bursaries dedicated to the SA-CERN programme. The number of visits for students (including postdoctoral fellows) is expected to treble from 2013 to 2019. Being part of a large collaboration exposes students and researchers to an international group sharing a very high standard of science, and the most advanced techniques and latest advances in software.

The growth experienced in academic, technical, and scientific staff and postdoctoral fellows who have been through the SA-CERN programme over the past few years of this partnership bodes well for growing South Africa's national competence to manage and promote a wide range of computationally and theoretically intense domains and projects, such as the Square Kilometre Array project, the Centre for High Performance Computing (and the SA-GRID initiative), the Radioactive Ion Beam project at iThemba, and the High Throughput Electronics Facility project at the University of the Witwatersrand.

These projects and others have benefited from an infusion of skills from students trained at CERN and researchers participating in CERN experiments, it is expected that this valuable cross-over of skills will continue.

The 2018 SA Physics Olympiad (SAPhO2018)

By Case Rijsdijk

Learners excel in Physics

On Friday, 8 September 2018 the South African Institute of Physics (SAIP) will announce the South African Physics Olympiad (SAPhO) results to the media, the schools involved and the learners who excelled in the SAPhO exam.

Over 100 learners from 69 schools were selected from almost 30 000 learners who wrote the SA National Youth Science Olympiad (SANYSO) to write SAPhO 2018.

"South Africa, like every other country in the world, has amongst its youth, a latent talent that needs to be identified, nurtured and monitored, to allow them to reach their full potential", says Case Rijsdijk, SAPhO Convener. "There are talent scouts for potential sportsmen and women, why not for maths and sciences? After all, our future lies in education and a technologically based economy. Identifying future scientists and engineers is essential, and SAPhO is one pathway to success."

Learners who do well in any other recognized science competition or Olympiad were invited to take part in SAPhO 2018 which was held on Monday, 13 August2018. The results for SAPhO2018 were most satisfactory with an average mark of 41%

The range of marks was from 76% to 21%. The organisers hope to increase the SAPhO footprint by attracting closer to over 300 learners to participate in the Olympiad next year; it might become an on-line Olympiad, in which case, more learners will get the opportunity to write SAPhO.

Matthew Johnstone, a grade 12 learner from York High School, George, Western Cape, was the top scoring learner in this year's Olympiad with a score of 76%. He will receive a Gold Certificate, R2 000 and the SAIP Medal, which will be presented to him at the Annual SAIP Conference dinner at the University of Venda in July 2019.

His teacher, Mr. Koos van Tonder said that "Matthew is one of the bright young minds in South Africa. His understanding of scientific problems and analytic mindset is outstanding.

Matthew himself said; "Physics is my passion. I want to study theoretical physics, not because of a job I can get, but because for as long as I can remember,

Matthew Johnstone.

I've had questions about the universe that only physics can answer". In second place was Graham Mitchell, a grade 12 learner from Pretoria Boys High, Gauteng, and last year's Bronze Certificate winner, who won this year's Silver Certificate with a score of 75% and R1 500.

He will also receive a Special Award Certificate for this remarkable achievement. Adri Wessels, from Curro Durbanville, who with 71%, scooped third place with a Bronze Certificate and R 1 000.

SAPhO will also award those who scored between 70% and 60% Merit Certificates for their achievements and those who scored between 59% and 50% will receive Honourable Mention Certificates. The remaining learners will receive Participation Certificates to acknowledge their participation in the Olympiad.

The SAPhO Convener, Case Rijsdijk, has said that he is grateful to the Department of Science and Technology, DST, and the South African Agency for Science and Technology Advancement, SAASTA, for their support and funding. In addition, he also voiced his thanks to the SAIP Executive Officer, Mr. Brian Masara, and the Project manager, Ms. Ndanganeni Mahani for all their efforts in making SAPhO a success, and finally, Mr. Peter Waker from Interware, for Analysis of the results.

SAPhO is hosted by the South African Institute of Physics (SAIP) with the aim of identifying young Southern Africans with ability in Physics, in the hope that these students will continue to study Physics at tertiary institutions and Universities within South Africa.

SAIP is the voice for Physics in South Africa. It is a professional body for practising physicists in a variety of disciplines ranging from Cosmology to Medical Physics. It has several goals, one of which is raising the awareness of Physics and its importance to our daily lives; much of which can be achieved through education.

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Matthew Johnstone from York High in George Receives the 2018 SA Physics Olympiad Top Award

By Brian Masara

In order for South Africa to develop a knowledge economy, the country needs to build a human capital base in Science Engineering and Technology. One way the South African Institute of Physics (SAIP) is helping to identify, nurture, monitor and mentor young people with the potential to excel in SET careers is through the South African Physics Olympiad (SAPhO).
This year, over 100 learners from 69 schools were selected from almost 30 000 learners to write SAPhO 2018. More details can be found here; http://saip.org.za/images/SAPho_Press_release_2018V2.pdf.

The SAPhO2018 Top Achiever and Gold Medallist was Mr. Matthew Johnstone, from York High School in George. He was presented with his award at York High on Friday 7 September 2018 by the SAPhO convenor Mr. Case Rijsdijk.

Case Rijsdijk (left), the convener of SAPhO, congratulates Matthew Johnstone and hands over his certificate, gold medal, and a tablet.

From left: Deryk Eckersley (York), Graeme Johnstone, Case Rijsdijk (SAPhO), Mathew Johnstone, Hilary Johnstone, Koos van Tonder (York) and Francois Moll (York headmaster). Photos: Myron Rabinowitz

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More details on the SAPhO2018 Whizz Kid award can be found here:

1.https://www.georgeherald.com/News/Article/General/yorkie-scores-top-in-sa-physics-olympiad-201809060826

2.https://www.georgeherald.com/News/Article/General/national-physics-whizz-kid-aims-for-the-stars-201809130938

Graham Mitchell from Pretoria Boys High Receives SAPhO2018 Silver/Special Award

By Ndanga Mahani

Graham Mitchell, a grade 12 learner from Pretoria Boys High, Gauteng, and last year's Bronze Certificate winner, won this year's Silver Certificate. He also received a Special Award Certificate for this remarkable achievement. He was presented with his award at Pretoria Boys High, on Monday 5th November 2018 by Brian Masara (SAIP Executive Officer), Prof Mmantsae Moche Diale (SARCHI, University of Pretoria and past SAIP Council Member) and Ndanga Mahani (SAIP projects Officer).

Graham also received a tablet with accessories and a book voucher. Graham thanked SAIP for the opportunity to take part in the SA Physics Olympiads, he also mentioned that Mrs Albers (HOD for Physical Sciences) inspired him to excel in physics. He is planning to pursue a degree in physics next year.

From left to right: Ms Mahani, Mr Masara, Graham Mitchell (Silver Medallist), Mrs JD Holliday (Deputy Headmaster) and Mrs D Albers (HoD, Physical Sciences).

Professor Diale congratulates Graham on his achievements.

Vhembe Teacher Development-Physical Sciences Workshop 23 -27 July 2018

A 5-day learner training was held at Vhembe District from the 23rd – 27th July 2018. Initial plans were to secure 2 fixed venues at which groups will be reporting. Each centre catering for 2 groups with each group coming for two days - One day for Physics and the other day for Chemistry. The model was going to result in the training running for 4 days. The last day was reserved for identifying a school or 2 where the team was going to teach learners.

The district changed focus from teachers to learners by requesting that instead of training teachers, they would like the SAIP team to directly teach grade 12 learners in selected schools they identified as underperforming and having high enrolment. They also requested that we target 5 or more schools listed below for at least 2 days per school.

Below are the schools and their locations:

1. Shingwedzi (Xingwedzi) is in Malamulele, Xihlelani, about 30 km from Thohoyandou
2. Marude is next to Univen
3. Miriyavhavha is at Ha-Khakhu, about 47 km from Thohoyandou
4. Nngweni is at Biaba, Makhado, Dzanani about 50 km from Thohoyandou
5. Milton Mpfumedzeni is at Lukalo, Tshaulu about 48 km from Thohoyandou

CONTENT FOCUS

Physics: (Electricity/Electrodynamics /Optical Phenomena/ Work, Energy & Power)
Chemistry: (Electro-chemical cells/Reaction Rate/Acids & Bases)

1.1 Planning

The team used the previous year strategy of having a planning meeting at SAIP2018 Conference in Bloemfontein. It was agreed in the meeting that the team leaders will identify experienced facilitators from their universities. The team also had another meeting a day before the training started at Muofhe Graceland. The same lodge was used as some team members were staying there. The 2 teams from Univen and UL was split into 2 groups, both having facilitators for both Physics and Chemistry.

1.2 Implementation

The group reported to 1 school for 2 days then the other school 3 days. On the last day of the training, the 2 groups went to Shingwedzi as it was the one with highest number of physical science learners thus a 3-day training was essential. The learners were divided into 5 rotating groups. The teams also learned that the school had science kits which were unopened. It was resolved that the school will liaise with Univen team, the Univen team promised to visit the school with a mobile lab so that learners can be exposed to different science experiments.

Group Arrangement:

1. Group 1 (Nngweni, Miriyavhavha)
2. Group 2 (Shingwedzi, Milton Mpfumedzeni)

Marude is a local school just near the Univen main gate, a separate training by Univen team will be arranged before exams.

1.3 The Team

Name	Institution	Subject Phy or Chem	Topic
Mr Letsoalo Molamo Ally	University of Limpopo	Physics	Optical Phenomena
Mr Netsianda Makondelele	University of Limpopo	Physics	Work, Energy Power
Prof Thuto Mosuang	University of Limpopo	Physics	Electrodynamics
Mr Vusi Ludwig Mulaudzi	University of Limpopo	Chemistry	Electro-chemical cells and Reaction Rate
Ms Mmaphefo Patricia Mothapo	University of Limpopo	Chemistry	Reaction Rate and Acids & Bases
Dr Joseph Kirui	University of Venda	Physics	Optical Phenomena
Dr Eric Maluta	University of Venda	Physics	Work, Energy Power
Mr Solomon Ravhengani	University of Venda	Physics	Electrodynamics
Ms Sedzani Mulaudzi	University of Venda	Chemistry	Reaction Rate and Acids and Bases

1.4 Statistics

A total of 493 Grade 12 learners were reached.

School	No of learners
Milton Mpfumedzeni	47
Miriyavhavha	90
Nngweni	100
Shingwedzi	256
Total	**493**

1.5 Photos

SAIP Teacher Development Team at Shingwedzi.

SAIP Teacher Development Team at Shingwedzi on Friday 27 July 2018.

SAIP Teacher Development Team at Nngweni Secondary School.

Miriyavhavha learners during class.

Milton Mpfumedzeni class.

IUPAP Newsletter

We would like to inform you that the June 2018 issue of the IUPAP newsletter is now online for your browsing. You can view it via the link (http://iupap.org/…/IUPAP-Jun2018-web-ilovepdf-compressed.pdf) or directly from the website (http://iupap.org/newsletter/).

We would like to inform you that the December 2018 issue of the IUPAP newsletter is now online for your browsing. You can view it via the link: http://iupap.org/wp-content/uploads/2018/12/IUPAP_dec_2018_final-compressed.pdf or directly from our website at: http://iupap.org/newsletter/.

Like the SAIP Facebook Page

Like the SAIP Facebook page to stay in touch with the latest news, events and job opportunities within the South African & International Physics Communities.

If you have interesting physics related activities, events and opportunities you want to be posted please let us know and share those great moments with the community.

https://www.facebook.com/South-African-Institute-of-Physics-1660099704207118/

Connect with SAIP on LinkedIn

The physics community can now connect with SAIP on LinkedIn click on the link below to connect with friends in physics community in South Africa: https://www.linkedin.com/company/18078401/

Happy networking!!

CRITICAL SKILLS VISA LETTER

The South African Institute of Physics is now a SAQA registered professional body hence it can provide critical skills letters required for the application of a Critical Skills VISA and Permanent Residence Permits to Registered Professional Physicist.
An application for a Critical Skills Work Visa has to be accompanied by proof that the applicant falls within the critical skills category and the following;

1. A confirmation, in writing, from the professional body, council or board recognised by the South African Qualifications Association (SAQA), in terms of Section 13(1)(i) of the National Qualifications Framework Act, or any relevant government department confirming the skills or qualifications of the applicant and appropriate post qualification experience.

2. If required by law, proof of application for a certificate of registration with the professional body, Council or board recognised by SAQA in terms of Section 13(1)(i) of the National Qualifications Framework Act.

3. Proof of evaluation of the foreign qualification by SAQA and translated by a sworn translator into one of the official languages of the Republic.
SAIP is recognised by SAQA and can provide you with the confirmations you require to comply with requirements 1 and 2 above.

Register as a Professional Physicist with SAIP

The SAIP is inviting its members to register as Professional Physicists (Pr.Phys) with SAIP.

- The short abbreviation for the designation will be Pr. Phys.
- A member registered with SAIP as a Professional Physicist can use the letters Pr.Phys after their name e.g. George Brown Pr.Phys.

Who can apply?

Physics is a basic science that is a basis for all science and technology disciplines. This results in its graduates working in every sector imaginable. Therefore, we must cater for a wide range of industries and economic sectors. Hence any physicists who graduated with at least Physics Honours Degree working in either; industry, commerce, government, academia, research, theoretical physics, experimental physics, and uses physics skills and thought processes in their job/career.

A person first has to qualify to be an SAIP Ordinary member before they can be registered as a professional physicist.

This designation will represent the highest standard of professionalism, competence and commitment to keep pace with advancing knowledge in the field of physics. It is hoped this designation will give a professional standing and recognition of physics by the South African society.

Justification

Academic qualifications are only the beginning of a career in physics and its applications. The need for continuing professional development is widely recognised to be the mechanism by which professionals maintain their knowledge after the formal education process has been completed. Pr.Phys demonstrates a commitment to maintaining competence, continuing your professional development and abiding by an acceptable code of conduct.

Benefits to physicist

- The certification as a Professional Physicists will be an important addition to a physicist's personal credentials.
- When competing for a job the designation will distinguish one from other applicants with similar qualifications but no professional designation

Benefits for employers

- Supports the recruitment process many recruiters these days want to know if one has a professional designation
- Can be used as criteria for promotion, skills and salary benchmarking
- Demonstrates to someone who possesses this designation believes in professionalism, continuous skills development, belonging to a professional body and acceptable ethical standards

Register as Professional Industrial and Physical Science Technologists (Pr.PhysTECH)

Pr.PhysTECH Designation: The SAIP would like to inform the physics community that a second professional designation, the Professional Industrial and Physical Science Technologists (Pr.PhysTECH) has now been registered with SAQA under professional designation ID: 899.

Pr.PhysTECH registered members also qualify to request a critical skills VISA support letter from SAIP. Pr.PhysTECH will cater for applied physicists, industrial physicists, technicians and technologists and graduates with physics-based qualifications working in academia, research and industry; who apply physics-based scientific-methods, techniques, concepts and principles in research, testing, measurement, monitoring, design, and installation of equipment, products, and processes.

For more info visit: http://saip.org.za/…/442-professional-industry-and-physical…

JOIN SAIP MEMBERSHIP

Physics is a basic science that is a basis for all science and technology disciplines. This results in physics graduates working in every sector imaginable. Therefore, SAIP caters for a wide range of industries and economic sectors.

SAIP membership includes any physicists who graduated with at least physics related degree working in either; industry, commerce, government, academia, research, theoretical physics, experimental physics, and uses physics skills and thought processes in their job/career.

Why Professional Membership is Important

Academic qualifications are only the beginning of a career in physics and its applications. The need for continuing professional development is widely recognised to be the mechanism by which professionals maintain their knowledge after the formal education process has been completed. By becoming a member of a professional society, one demonstrates their commitment to maintaining competence in their field through continuing your professional development from activities such as conferences, schools and workshops and abiding by an acceptable code of conduct. Membership of a professional society is an important addition to a physicist's personal credentials for example when competing for a job membership of professional society will distinguish one from other applicants with similar qualifications but no professional affiliation.

1. **Stay informed -** News flashes and alerts to are sent directly to your email. A quarterly magazine, Physics Comment, will keep you briefed on physics news, government policy and jobs in industry and academia.
2. **Specialist Groups and Networking - Through** the various activities of SAIP, networks have been established with the African and International Physics communities, to benefit all our members. You'll make important new contacts and forge lifelong professional relationships by getting involved in a specialist group.
3. **Save Money -** You'll receive discounted rates for SIAP conferences, and have the benefit of paying affiliate membership fees for IOP membership.
4. **Employment opportunity information -**Job advertisements will be displayed on our new website and mailed to members from time to time.
5. **Access to current information on sources of funding grants and scholarships** - Exclusive service provided to our members via a direct email system.
6. **Scientific meetings** - The annual conferences and workshops provide learning opportunities for different specialisation areas and varying degrees of experience.
7. **Especially for the global physics community - You'll** have the opportunity to partake in events organised by the SAIP for the Physics community in South Africa as well as Africa: developmental workshops, schools, and conferences.
8. **Additional resources -** Your membership privileges also include information and guidance when applying for and acquiring visas to study, participate in the scientific meeting and research opportunities in South Africa and abroad. There is also an exclusive member-only area on our website.
9. **Career guidance and resources**- Career assistance is provided to all members to find their career path in industry or academia.
10. **Opportunities to win awards for excellence** - SAIP recognises contributions to physics in SA by awarding two different medals and various student prizes at the annual conference.
11. **Teaching and Learning Resources for schools** - As part of our growing outreach programme we provide teachers and learners with the tools and opportunities to allow and motivate more learners to follow careers with physics as a background

JOIN SAIP TODAY CLICK THE LINK BELOW FOR MORE INFORMATION ON HOW TO APPLY:

http://www.saip.org.za/index.php/members/membership-info

The Nobel Prize in Physics 2018

https://www.nobelprize.org/prizes/physics/2018/press-release/

The Nobel Prize in Physics 2018 was awarded "for groundbreaking inventions in the field of laser physics" with one half to Arthur Ashkin "for the optical tweezers and their application to biological systems", the other half jointly to Gérard Mourou and Donna Strickland "for their method of generating high-intensity, ultra-short optical pulses."

Tools made of light

The inventions being honoured this year have revolutionised laser physics. Extremely small objects and incredibly rapid processes are now being seen in a new light. Advanced precision instruments are opening up unexplored areas of research and a multitude of industrial and medical applications.

Arthur Ashkin invented optical tweezers that grab particles, atoms, viruses and other living cells with their laser beam fingers.

This new tool allowed Ashkin to realise an old dream of science fiction – using the radiation pressure of light to move physical objects. He succeeded in getting laser light to push small particles towards the centre of the beam and to hold them there. Optical tweezers had been invented. A major breakthrough came in 1987, when Ashkin used the tweezers to capture living bacteria without harming them. He immediately began studying biological systems and optical tweezers are now widely used to investigate the machinery of life.

Gérard Mourou and Donna Strickland paved the way towards the shortest and most intense laser pulses ever created by mankind. Their revolutionary article was published in 1985 and was the foundation of Strickland's doctoral thesis.

Using an ingenious approach, they succeeded in creating ultrashort high-intensity laser pulses without destroying the amplifying material. First they stretched the laser pulses in time to reduce their peak power, then amplified them, and finally compressed them. f a pulse is compressed in time and becomes shorter, I then more light is packed together in the same tiny space – the intensity of the pulse increases dramatically.

Strickland and Mourou's newly invented technique, called chirped pulse amplification, CPA, soon became standard for subsequent high-intensity lasers. Its uses include the millions of corrective eye surgeries that are conducted every year using the sharpest of laser beams. The innumerable areas of application have not yet been completely explored.

However, even now these celebrated inventions allow us to rummage around in the microworld in the best spirit of Alfred Nobel – for the greatest benefit to humankind.

Arthur Ashkin
Prize share: ½

Gérard Mourou
Prize share: ¼

Donna Strickland
Prize share: ¼

Ill. Niklas Elmehed. © Nobel Media

Congo …. Science Centres Would Be a Game Changer

By Dr Benjamin Lawson - Christian Bilingual University of Congo (UCBC)

My path was never clearly set on science education. Throughout my time at the University of Texas as an undergraduate, I studied physics because I found the subject interesting and challenging. I continued my education at the University of Michigan, not with the objective to going into academia or private sector R&D, but rather, because I enjoyed learning. Even upon finishing my Ph.D., I faced three very different career paths with an offer in the private sector from Intel, a postdoc position at Duke, and an invitation to join the department of Applied Sciences at the Christian Bilingual University of Congo (UCBC) in eastern DRC.

At the time, my choice to move to Congo was not at all clear, and I was interested in all three options. In hindsight, my decision was not due to a larger sense of purpose or a desire for adventure, but rather a unique sense of opportunity. I have felt deeply affirmed in my choice every step of the way.

The challenges of teaching STEM in eastern Congo are substantial. The secondary education is extremely poor with an emphasis on learning by rote and a culture of accepting the instructor's words as gospel. The resources are limited, not only in physical materials like lab equipment, but also in reliable electricity, internet, and, most importantly, qualified teachers. And worst of all, chronic regional instability and poor governance produces a plethora of obstacles in an otherwise already difficult situation.

However, our university was founded with the philosophy of being transformed to transform. In that, we aim to equip competent, moral, engaged leaders in all sectors of society - business, technical, communal, and political - to bring change to Congo. This vision for generational change cannot wait until the situation improves, it must start in and amongst the challenges - engaging them at every level. We believe that quality, transformative education is the key to transforming the status quo in eastern Congo.

UCBC Welcome Centre Pano.

Recently my colleague and I, Othy, attended the International Conference on Physics Education (ICPE) in Johannesburg. This has been a very encouraging experience for both of us. First of all, the ICPE provided us with crucial exposure to the cutting edge in STEM pedagogical ideas. Currently, we are rebuilding our curriculum from ground up to cultivate alumni with an inquisitive, scientific mindset. Exposure to the ideas at the conference has helped inform this process. In addition, Derek Fish, a delegate at the conference from Unizulu Science Centre, and PASCO donated a set of sensors and related software to allow us to do hands-on interactive activities in our university and affiliated primary school classrooms. These tools are catalytic in our transition from lecture-based teaching to active learning classrooms, and they will have a profound impact.

Congo Library.

One of our greatest needs is exposure to new ideas and new ways of thinking and learning. At the ICPE, we had lengthy discussions about interactive science centres. Such a thing would be a game changer in our context. In a place where rote memorization is the norm, an interactive science centre would provide not only a platform to change the way students approach and think about learning, but it would give teachers at all levels exposure to a new way they could run their classrooms. This would complement UCBC's objective of leading systemic change in how education is done in our context.

Lastly, at the conference, we were able to make our story known. Often, the world forgets Congo or chooses to look the other way - viewing it as a hopeless heart of darkness. However, in my experience, I've seen more hope in Congo and energy to seek change than anywhere in the world. Sharing our story and our mission is the first step to changing the outside world's view of Congo and getting people involved. Solving difficult problems is what we do in the sciences. We do not pursue problems that are easy, but ones that are hard. To all who would like to solve hard problems, who do not want to view Congo as a place that is just "too complicated", come and visit - just come and see what is being done.

Beni in Congo.

2018 Global Survey of Mathematical, Computing, and Natural Scientists!

You are invited to participate in the 2018 Global Survey of Mathematical, Computing, and Natural Scientists which part of an interdisciplinary collaboration of eleven partners, supported by the International Council for Science (ICSU), which aims to better understand the problems mathematical, computing, and natural science academics and practitioners are facing around the world.
The data are being collected by the non-profit Statistical Research Center of the American Institute of Physics. Responses to this survey are voluntary, and your individual information will be held in strict confidence.

Please forward this survey to anyone who has studied or worked in mathematics, computing, natural sciences, or the history and philosophy of science and technology.

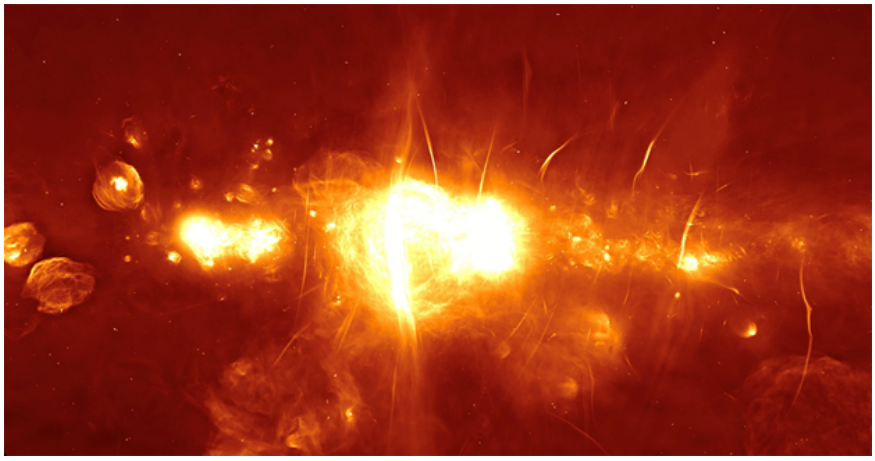
For more info please follow this link: http://saip.org.za/…/446-2018-global-survey-of-mathematical…

South Africa's MeerKAT radio telescope

Article retrieved from:

http://www.ska.ac.za/media-releases/meerkat-radio-telescope-inaugurated-in-south-africa-reveals-clearest-view-yet-of-center-of-the-milky-way/

The image below, based on observations made with South Africa's MeerKAT radio telescope, shows the clearest view yet of the central regions of our galaxy. At the distance of the galactic centre (located within the white area near image centre), this 2 degree by 1 degree panorama corresponds to an area of approximately 1,000 light-years by 500 light-years.



The high resolution image can requested from the SKA office.

The colour scheme chosen here to display the signals represents the brightness of the radio waves recorded by the telescope (ranging from red for faint emission to orange to yellow to white for the brightest areas). This image shows a wealth of never before seen features, as well as a clearer view of previously known supernova remnants, star-forming regions, and radio filaments.

MeerKAT's 64 dishes or antennas provide 2,000 unique antenna pairs, far more than any comparable telescope. This design feature contributes critically to making high-fidelity images of the radio sky, including this best view in existence of the centre of the Milky Way. It is also advantageous to observe the centre of the galaxy from South Africa, where it passes overhead and is visible for almost 12 hours each day, unlike from northern hemisphere locations.
Radio array telescopes do not measure the very largest, smooth structures in a given region of the sky. That additional information can be obtained using single dish radio telescopes; for the MeerKAT image shown here, that information is from the Green Bank Telescope (courtesy of Bill Cotton, NRAO.

The SI units, Metrology in South Africa and the road to the Revised SI

By Dr Wynand Louw and Dr Aletta Karsten, NMISA
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Introduction

Accurate, comparable measurement depends on globally agreed units of measure, an independent way of realising the "base" units according to an agreed method and the establishment of common references traceable to the realisation of these base units. The Metre Convention (Convention du Mètre) of 1875 is the basis for international agreement on units of measurement and created the International Bureau of Weights and Measures (BIPM), an intergovernmental organisation under the authority of the General Conference on Weights and Measures (CGPM) and the supervision of the International Committee for Weights and Measures (CIPM)[1]. This system governs the global measurement system, today known as the International System of Units with its 7 base units the **second**, the metre, the kilogram, the ampere, the **kelvin**, the **mole** and the **candela**[2].

The history of the International System of Units (the SI)

Before the metric system was initially accepted by 17 main industrial nations as a global measurement system, a myriad of measurement units existed, most with their origin in ancient times or based on body dimensions. In pre-19th century Europe many units of measure were adopted from Roman units3 and many more were added. Weights and measures not only varied between nations, but also within nations and it is estimated that before the French revolution, in France alone, there were more than 250 000 different units of weights and measures4. At least some countries such as the UK standardised units of measure within the nation, but it remains difficult to trade fairly and not to fall victim to unscrupulous behaviour where artefact units of measure were "changed" to favour one party.

The history of the metric system seemingly started during the French revolutions when revolutionaries tried to fundamentally alter society by overthrowing old traditions and habits, but it can be traced back to more than a century before when a number of scientists and astronomers in Europe tried to find a more "universal" measure. In 1670 Gabriel Mouton, a church vicar in Lyons, proposed a decimal system of units based on natural constants with a measure for length as the basis. Two very different propositions were made for the choice of the basic unit of length: the length of one minute of arc of a great circle of the earth (now called a nautical mile, 1852 metre) and the swing-length of a pendulum with a frequency of one beat per second. But, it took more than a century and the drive of the revolutionaries for France to finally adopt in 1795 the principle of an invariable standard of weights and measures based purely on nature, having as its basis a unit of length based on the Earth's circumference (thus an adaptation of one of the original ideas), called a "metre" from the Greek word for measure, metron. The metre was constructed to equal a fraction of the distance from the North Pole to the equator[5].

The group of scientists that came up with the concept assigned two astronomers to determine the distance from the North pole to the Equator. The method they used to physically measure the distance between two points on a meridian (line of longitude) and to use trigonometry to calculate the circumference of an object or triangulation for distances on earth was nothing new, astronomers used it for centuries to navigate and determine distances at sea and as early as 240 BC Eratosthenes, a Greek mathematician working as a librarian in the Library of Alexandria, measured the length of the shadow of the tower of Alexandria to calculate the angle of the sun on the summer solstice, then used the well-known distance between Alexandria and Syene (modern Aswan, Egypt) that is near the Tropic of Cancer, to calculate the circumference of the earth to a remarkable accuracy of a few percent[6].

But to perform the measurement to the accuracy required was no mean feat and became a major scientific (and logistical) endeavour[7]. A surveying team under the direction of Pierre-Francois-Andre Mechain and Jean-Baptiste-Joseph Delambre spent 6 years in measuring the "arc" that the earth made in a line between Dunkirk in France on the English Channel and Barcelona in Spain and calculated the length of the quadrant of the earth.

The "metre" was then defined as one ten-millionth of the length of the quadrant (so one forty-millionth of the polar circumference of the earth). It was later found that Delambre and Mechain had not properly accounted for the earth's flattening in correcting for oblateness. However, the metre remains the invariable standard for the metric system, and its length has not changed even though the official expression of the definition the metre has changed several times to improve the accuracy of its measurement[8].

Figure 1: One of the last remaining 'mètre étalons', or standard metre bars, can be found below a ground-floor window on the Ministry of Justice in Paris (Credit: PjrTravel/Alamy).

The metre was subdivided into smaller decimals, i.e. one tenth is a decimetre, one hundredth is a centimetre and one thousandth 1/1000th is a millimetre and was used to define a set of "base" units. The first was the unit of mass the "gram" defined as the mass of a cubic centimetre of pure water at its temperature of maximum density, of which 1000 gram was later decreed as the unit of mass, the kilogram. To disseminate the units a system of artefacts were introduced to represent the determinations (it would have been very difficult to accurately reproduce the realisation of the units at other locations-although in principle it was possible). Subsequently two platinum standards were deposited and placed in the Archives de la République in Paris[8].

Copies of these were then made of iron and distributed to a group of scientists from other countries invited to France to "witness" the new system, but its uptake in other countries were slow, most probably due to the war still raging in Europe. Even in France a period of uncertainty for the metric system ensued with slow uptake and it being abandoned for a "compromise" system by the Napoleonic government and only later re-introduced, but scientists continued to develop the system and the "second" was added as another "constant of nature", forming the so called cgs (centimetre, gram, second) system[9].

In 1820 the metric system was introduced by law in Holland, Belgium and Luxembourg and this was followed by Spain, Colombia, Mexico, Portugal and others10. In 1864 the use of metric weights and measures concurrently with those of the Imperial system was authorised in Great Britain and a few years later the metric system was introduced in Germany. The French government in 1869 invited numerous countries to send delegates to Paris for an "International Commission of the Metre" that lead to 24 countries expressing that the metre and kilogram of the "Archives de Paris" should be the reference for new prototypes and various copies to be constructed and distributed among the participating countries. Unfortunately the work was interrupted by the Franco-Prussian war and it was only on 20 May 1875 that 17 countries signed the "Convention du Mètre" that was the official start of a worldwide-uniform system of measurement.
The system at this point was thus based on three base units from which other units could be defined, at present called "derived" units. An example is the physical quantity "velocity" that is defined as distance travelled per unit time and as a consequence the "coherent" unit is defined to be the centimetre per second (cm/s). In this way every quantity could be defined with its corresponding coherent unit.

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The system was now well in place for the "mechanics", but problems arose when electrical phenomena had to be considered. The original proposal from Gauss in 1832 was to express geomagnetic measurements in terms of mechanical units of force and he introduced an "absolute" unit system for the electrical units based on the CGS-unit system. For the next 40 years appropriate units for all electrical quantities were defined in terms of the mechanical quantities' length, time, force and work by Faraday, Thomson, Maxwell, Weber and many others. But the electrical and magnetic phenomena could be described by two mutually incompatible systems of equations, depending on whether one started from the inverse-square distance force law between two magnetic poles or from that between two electric charges. For each of the two systems Weber in defined in 1851 a coherent "absolute" CGS unit systems; the electromagnetic and the electrostatic systems.

The electromagnetic CGS-unit of electrical resistance thus turned out to be one centimetre per second and a standard resistance in the form of a resistance coil could be prepared, the value of which in electromagnetic CGS-units was obtainable with a sufficient precision of about 1 in 10 000. However, the size of the electromagnetic CGS-units proved to be too small for practical use and the ohm for resistance and volt for electromotive force, equal to 109 and 108 times the corresponding CGS unit, were introduced in 1881. An even more practical unit was also introduced; the ampere for electric current, equal to 1 tenth of the corresponding electromagnetic CGS-unit, followed by the coulomb for electrical charge and the farad for capacitance. The requirement of coherence of the unit system with the system of equations relating the various physical quantities now made it necessary to add to the three base quantities a fourth base quantity of electrical nature. This would mean that the electrical quantities are no longer defined in terms of the three "mechanical" quantities but in the force law for the magnetic interaction. A constant was needed -the vacuum permeability. The value of this constant followed from the independent choice of the electric units to be 10-7 MKS-units of force per ampere-squared.

The basic quantity of fundamental nature in electricity, electric charge or current would play the same fundamental role in electrical units that mass plays in mechanics. But there were conceptionally two very different schools of thought of how to set up a unit system: on one hand a metrological point of view which was to define a measuring standard for every quantity with primary standards for a set of base units, on the other the systematic point of view which looked primarily at the algebraic rules, which any unit system -coherent with a system of equations between physical quantities -has to satisfy.

These opposing views and a few wars, including the First World War, resulted in the debate lasting for nearly 50 years. An important development during this time was that the Maxwell set of equations was "rationalised" to get rid of fractional components in the formal unit expressions by adding a factor 4π in various places they would logically occur and dropping them from others.

Finally, in 1935 the systematic point of view prevailed and the CIPM decided that:

(1) the permeability of vacuum, in the rationalised form of writing the equations, was defined to be 4π X 10-7 newton per ampere squared, where the newton was introduced as a new name for the MKS-unit of force.

(2) a definition of the ampere in terms of the force between two parallel conductors was considered to be the most appropriate basis for deriving all the other practical electrical units.

But the Second World War interfered, and it was only by 1946 that the CIPM confirmed its previous decision and set the date for the implementation of the fourth base unit, the ampere, to be 01 January 1948. The 9th CGPM in 1948 then ratified the resolutions of 1946 and published "Definitions of the mechanical units which enter the definitions of electrical units"2 The development of the set of base units to this point thus took more than 150 years from the first introduction of the Metric system!

The lessons learned during the Second World War that if ammunition or components are manufactured in a certain location for guns, aircraft, etc. manufactured in another location in the world, a high degree of not only accuracy but precision is needed, otherwise the components and main system may be incompatible, undoubtably supported standardisation and improvements in accurate measurement. The period 1946 onwards saw the establishment of standards bodies, science councils and national metrology institutes across the globe. This further stimulated the tendency to further intensify international collaboration and to advance understanding in science and technology, industrial and trade relations. Although the metric system was used in many countries, there still existed a large diversity of systems and there was by no means an "international measurements system" in place. The International Union of Pure and Applied Physics expressed the need for the international adoption of an "international practical system of units", to be based on the four base units of the metric system. This was supported by the French government and in 1954 the 10th CGPM approved a resolution submitted by the CIPM that such an international practical system should be based on six base units, the metre, kilogram, second, ampere, kelvin and candela.

The reasons for the introduction of the kelvin and candela were that so far, the physical phenomena for which a unit system was designed were of purely mechanical, electrical or magnetic nature, such that their description in terms of physical quantities could be based entirely on the four base quantities: length, time, mass, and electric current. However, for the description of thermal phenomena a new base quantity, the thermodynamic temperature, had to be introduced both for systematic and for metrological reasons. The ratio of the thermodynamic temperatures of two systems is determined by thermodynamics — using a Carnot cycle — in terms of the ratio of two amounts of heat (or energy).

In agreement with the procedure followed in defining standards for other base quantities it is then sufficient to attach — by definition — a certain numerical value to the thermodynamic temperature of one particular physical state. In 1948 the General Conference had selected this physical state to be the triple point of water and in 1954 the corresponding thermodynamic temperature was defined to be 273,16 kelvins (still called the degree Kelvin at this time).

For the description of the phenomena of light it appears that three base quantities are sufficient: length and time and one physical quantity of luminous origin for which the luminous intensity has been chosen. The candela, the unit of luminous intensity, is then defined as the luminous intensity in the perpendicular direction of a particular area of a blackbody at a certain specified temperature. This definition was approved by the General Conference in 1948 and was put in its final form in 1968.

In 1960 the 11th General Conference gave the name "International System of Units" to the unit system based on the six base quantities and units already introduced in 1954.

At the 14th CGPM in 1971, after lengthy discussions between physicists and chemists, the current version of the SI was completed by adding the mole as the base unit for amount of substance, bringing the total number of base units to seven.

The Establishment of the National Metrology Institute of South Africa (NMISA)

It was during the post-war period that the metrology system in South Africa developed to a point where a specific laboratory was established to be responsible for metrology. The history of official accurate measurement in South Africa can be traced back to the first scientific institution in the country, The Royal Observatory in Cape Town, established in 1820, that maintained mechanical clocks as the standard for time. Before 1820 measurement units used in the Netherlands and Germany were introduced to the Cape and the unit of length used was the “Rhynland Rood”, based on an artefact in the form of a 12 foot long iron bar embedded in the courthouse wall in Leiden (the Netherlands). In 1807 a comparison had been made with the French “legal metre” as 0,31395 metres. By 1820 the Cape was a British colony and the English foot, defined as 0,3048 metres, was introduced for local use. Thus 1000 Rhynland feet were equivalent to 1030 English Imperial feet11. But two Rhynland Rood rods were in use in the Cape at this time that turned out to be slightly longer than the standard Rhynland Rood and after an extensive investigation by a Commission using the No. 17 copy of the British imperial standard yard, it was concluded that 1000 of the feet in use should be rounded off to 1033 British feet. A law was passed that established the “Cape foot” as the official reference standard for length! The equivalent in metre is 314,858 1 mm12. 1922 saw the establishment of a department of Assizes (Weights and Measures), the forerunner of the Trade metrology department in the Department of Trade and Industry (the dti) that later moved to the South African Bureau of Standards and finally became “Legal metrology” under the National Regulator for Compulsory Specifications (NRCS)[13].

Following the establishment of the Union of South Africa in 1910, the Johannesburg Observatory established in 1908 became the Union Observatory in 1910. It first started as a meteorological institution (the science associate with the processes and phenomena of the atmosphere) and later became an Observatory. A small transit telescope was used to determine (transit) time and a time signal was sent to the Johannesburg Post office. The time service was extended to Natal in 1908 and at noon every day a time ball would drop at the Bluff in Durban following a signal from Johannesburg. The accuracy of the time service was about 0,25 seconds. Five years later three Riefler clocks were acquired and the signal accuracy was improved to 0,2 seconds. These clocks provided the time service until 1948 when it was replaced by a quarts-clock.

After the Second World War South Africa followed the example of many countries in the world and established a science council, the Council for Scientific and Industrial Research (CSIR). The Scientific Council Act stated that
"The CSIR shall maintain primary scientific standards of physical quantities for the Republic. and compare those standards with international standards from time to time" and by 1947 a "National Physical Laboratory" was established under Dr Meiring Naude.

The first parameters for which standards were established included temperature, electrical and mass. Spectrochemistry, optics and X-ray departments followed and by 1950 pressure and electro-acoustics were added. The process to sign the Metre Convention and acquire a certified standard kilogram were initiated, but the authorities was not keen, mostly due to financial reasons. A copy of the International Prototype of the Kilogram (IPK) was ordered from Oertling in the UK (in anticipation of becoming a signatory to the Convention) and in 1956 it was standardised by the BIPM and the number, "56" was assigned to it. But the political changes in South Africa and the move towards a Republic resulted in the Republic of South Africa becoming the 40th signatory of the Metre Convention in 1964 only. The metrology laboratory was now called the National Research Laboratory (NPRL) and in 1972 the responsibility for the maintenance of the time standard was at last transferred to NPRL when the combined South African Astronomical Observatory was brought under the control of the CSIR.

The next milestone was the promulgation of the "Measuring Units and National Measuring Standards Act 76 of 1973" that assigned the executive authority for metrology in South Africa to the dti. This followed lobbying by the then managers of NPRL to establish a non-profit institution responsible for metrology, reporting directly to the dti. But the Act assigned the legal responsibility for all "national measuring standards" to the CSIR, paving the way for the CSIR National Metrology Laboratory (CSIR NML), a situation that would remain until the Measurement Unit and Measurement Standards Act, No. 18 of 2006, established the NMISA.

By the early 1980's the National Calibration System (NCS) was formed in response to a growing need for a proper quality assurance system and also the decision to build South Africa's first nuclear power station, Koeberg. It was primarily a secretariat, with staff members of the NML providing the resources for laboratory accreditation, training courses and other activities. In 1993, following the international example of accreditation bodies reporting directly to government to ensure that there was no conflict of interest, the CSIR agreed with the dti for the NCS to become independent and the new NCS came into being on 16 March 1994, later established as the South African National Accreditation System (SANAS).

Responding to a request from the dti in 2002 to improve the visibility of the NML within CSIR, the CSIR responded by elevating the NML from a programme under the (then) Materials Technology division of CSIR (Mattek) to a "centre of CSIR". The same principle was then applied to a group of programmes with specific national assignments (Satellite Application Centre, National Laser Centre, Meraka and NML) to form the "Centres of CSIR". The group was managed by a Director that reported directly to the President of CSIR. During this period the dti performed a study on the "technical infrastructure" needs for South Africa and concluded by 2004 that the "Technical infrastructure of South Africa" (the quality infrastructure (QI) internationally) should consist of 4 autonomous public institutions for the 4 legs of the QI.

At this time only the "standards" leg existed as an institute, the South African Bureau of Standards (SABS). Legal metrology was under the SABS, the NCS reported to the dti as a non-profit organisation and scientific metrology was under the CSIR. In the period 2005 to 2008 national Acts were developed for Scientific metrology that created the NMISA in 2007, accreditation that established SANAS in 2007 and compulsory specifications that established the NRCS in 2008.

The establishment of NMISA and the independence from its founder organisation CSIR had profound consequences for the organisation. It allowed for a higher profile regionally and internationally, a more focused approach on metrology, more funding from the dti for metrology, but to a great extend severed the scientific links to the Science Councils and the department of Science and Technology. The Minister of Science and Technology in 2013 confirmed that NMISA is a National Research Foundation (NRF) recognised "Research Institution", assisting NMISA to rebuild its formal ties with the science community in South Africa.

The recognition of the scientific excellence of a metrology institute is primarily through membership of the Consultative Committees of the CIPM. Ten committees exist that coordinates scientific work in metrology world-wide and establish global comparability of measurements through promoting traceability to the SI, namely for mass and related quantities (CCM), temperature (CCT), electricity and magnetism (CCEM), time and frequency (CCTF), acoustics, ultrasound and vibration (AUV), photometry and radiometry (CCPR), amount of substance (CCQM), Ionising Radiation (CCRI), length (CCL) and units (CCU). Membership of a Consultative Committee is open to institutions of Member States that are recognised internationally as most expert in the field. This normally requires that they:

- be national laboratories charged with establishing national standards in the field;
- be active in research and have a record of recent publications in research journals of international repute;
- have demonstrated competence by a record of participation in international comparisons organised either by the Consultative Committee, the BIPM or a regional metrology organisation.

By 2002 the CSIR NML held membership of two CCs and by 2015 this has increased to official membership of 8 CCs and attendance of the other 2, with Dr Wynand Louw having a seat on the CCRI as the President of CCRI and a guest seat on the CCU in his capacity as CIPM member and President of CCRI. NMISA has achieved the goal that every NMI sets -membership or attendance of all the CCs of the CIPM and having a member elected to the CIPM. NMISA is the only NMI in Africa that has membership of the CCs and NMISA thus represents the African region at the CCs.

The revised SI and NMISA's role

Over the years numerous changes were made to the SI, with the ultimate drive to define all the SI units in terms of fundamental constants of nature. In this way the SI units can be realised in any country with the required expertise and equipment. By the end of the 1970's most units were defined based on fundamental constants of nature, but the definition of the kilogram, still depended on a material artefact, the International Prototype Kilogram (IPK), housed at the BIPM in Paris, making it impossible to realise the kilogram at any place at any time. The definitions of two other units, namely the ampere and mole, were also related to mass. During the past 50 years it became evident that the mass of the artefact IPK may be drifting -an unsatisfactory situation as it influenced the values of three base units.

The kelvin, the base unit for temperature, is currently defined in terms of an intrinsic property of water that, while being an invariant of nature, in practice depends on the purity and isotopic composition of the water used. A new definition was also needed. The definitions of the units of time (second), luminous intensity (candela) and length (metre) were since the 1970's redefined in terms of "quantum" constants namely the second in terms of the transition between two hyperfine levels of the caesium atom υ(hfs Cs) = 9 192 631 770 hertz, the candela in terms of monochromatic radiation of frequency 540 x 1012 hertz and the metre in terms of the distance that light travels, i.e. the speed of light. These three units are therefore defined in terms of fundamental defining constants.

It seemed logical to define the other units also in terms of fundamental, defining constants, and the metrology community over a period of more than 30 years developed the theory and practical realisations to be able to redefine the four units as follows;

- Mass, measured in kilogram (kg) in terms of the Planck constant,
- Electric current, measured in in ampere (A) in terms of the elementary charge (electron or proton),
- Thermodynamic temperature, measured in kelvin (K) in terms of the Boltzmann constant,
- Amount of substance, measured in mole (mol) in terms of the Avogadro constant.

The decision to change the definitions of the SI units were formally taken at the CGPM meeting on 16 November 2018, to come into force on World Metrology Day, 20 May 2019.

All SI unit definitions are now based on constants that describe the natural world. A summary of the SI units with their "defining constants" is given in Table 114.

More info on the background on the revised SI units are available on the BIPM website[15].

Table 1: Definitions of the SI units

Quantity	SI unit
time	The second, symbol s, is the SI unit of time. It is defined by taking the fixed numerical value of the caesium frequency $\Delta\nu_{Cs}$, the unperturbed ground-state hyperfine transition frequency of the caesium 133 atom, to be 9 192 631 770 when expressed in the unit Hz, which is equal to s^{-1}.
length	The metre, symbol m, is the SI unit of length. It is defined by taking the fixed numerical value of the speed of light in vacuum to be 299 792 458 when expressed in the unit m s^{-1}, where the second is defined in terms of the caesium frequency $\Delta\nu_{Cs}$.
mass	The kilogram, symbol kg, is the SI unit of mass. It is defined by taking the fixed numerical value of the Planck constant h to be 6,626 070 15 $\times 10^{-34}$ when expressed in the unit J s, which is equal to kg m^2 s^{-1}, where the metre and the second are defined in terms of c and $\Delta\nu_{Cs}$.
electric current	The ampere, symbol A, is the SI unit of electric current. It is defined by taking the fixed numerical value of the elementary charge to be 1,602 176 634 $\times 10^{-19}$ when expressed in the unit C, which is equal to A s, where the second is defined in terms of $\Delta\nu_{Cs}$.
thermodynamic temperature	The kelvin, symbol K, is the SI unit of thermodynamic temperature. It is defined by taking the fixed numerical value of the Boltzmann constant to be 1.380 649 $\times$ $^{-23}_{10}$ when expressed in the unit JK^{-1}, which is equal to kg m^2 s^{-2} K^{-1}, where the kilogram, metre and second are defined in terms of h, and $\Delta\nu_{Cs}$.
amount of substance	The mole, symbol mol, is the SI unit of amount of substance. One mole contains exactly 6,022 140 76 $\times 10^{23}$ elementary entities. This number is the fixed numerical value of the Avogadro constant, $_A$, when expressed in the unit mol^{-1} and is called the Avogadro number. The amount of substance, symbol n, of a system is a measure of the number of specified elementary entities. An elementary entity may be an atom, a molecule, an ion, an electron, any other particle or specified group of particles.
luminous intensity	The candela, symbol cd, is the SI unit of luminous intensity in a given direction. It is defined by taking the fixed numerical value of the luminous efficacy of monochromatic radiation of frequency 540 $\times 10^{12}$ Hz, K_{cd}, to be 683 when expressed in the unit lm W^{-1}, which is equal to cd sr W^{-1}, or cd sr kg^{-1} m^{-2} s^3, where the kilogram, metre and second are defined in terms of h, and $\Delta\nu_{Cs}$.

NMISA is currently involved in projects related to the primary realisation of mass (kilogram) and amount of substance (mole) according to the proposed "recipes" for the realisation based on the revised definitions, with planned future involvement in the temperature and current realisations through co-operation with local universities and other metrology Institutes.

One of the two proposed methods to realise mass, defined in terms of Planck's constant, is through a Watt balance (later renamed to a Kibble balance in honour of the developer of the concept). The Watt balance is an instrument that uses an electromagnetic force to balance the weight of an object. In the system the current (I) and the voltage (V) are measured and therefore the name Watt balance (current x voltage = watt).

The basic operating principle of the Watt balance is shown in Figure 2.

(a) (b)

Figure 2: The interacting modes of a Watt balance (a) The Force mode: where an appropriate current I is used to attaining an equilibrium state between the weight mg of the test mass and the electromagnetic force BLI. (b) The velocity mode: where voltage V is induced when a coil is moved through the magnetic field at a constant velocity v.

By combining the two equations and assuming the $B\,L$ is the same in both equations,

$$VI = mgv$$

and therefore

$$m = \frac{VI}{gv}$$

Once the Quantum Hall effect and the Josephson effect is incorporated in the equations for the measurement of the current and the voltage, mass is then measured in terms of Planck's constant.

More information regarding the operation can be found on the NIST website16.

NMISA is working together with National Physical Laboratory (NPL), the UK Metrology Institute, on the development of a table-top Kibble balance model as well as the development of a less accurate mobile system to be used for schools and science expos.

A collaboration was also started with the Physikalish Technische Bundesanstalt (PTB), the Federal Republic of Germany metrology institute, on the "X-ray Crystal Density" project where a Si28 sphere with known dimensions can be used to determine the number of Si-atoms in the sphere, and this can be used to determine both the mass and the amount of substance.

For the future realisation of the ampere and to use the revised definitions for quantum measurements, two exciting projects are underway with the Physics departments at UCT and WITS on single electron transfer devices (for the determination of the elementary charge) and the use of structured light for metrology applications.

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Newsletter for Physics in Africa

By Professor Igle Gledhill (University of Witwatersrand)

Prospectus

Objective:

This document defines the basic framework for the creation and maintenance of a newsletter devoted to physics in Africa. The newsletter will be a means for African physicists to communicate with physicists outside of Africa, for African physicists to communicate among themselves, and for physicists and organizations outside of Africa to communicate with those in Africa. Presently, no such means exist for each of these three needs.

Overview:

The need for better means of communication with and among African physicists is one the areas of need identified by the survey of African physics conducted by the Physics in Africa Project sponsored by the American Physical Society, the European Physical Society, South African Institute of Physics, and the International Center for Theoretical Physics. Relying on African volunteers, the proposed newsletter will be a low cost, historic step forward to addressing the communication void.

The newsletter will publish quarterly. Quarterly gives the newsletter the desired character of an event emphasizing the current and immediate future. Monthly is too frequent for the likely amount of publishable news, and semi-annually is too infrequent to sustain interest. Subscriptions will be free and open to anyone in and outside of Africa. The growth in the number of subscribers will be a metric of its success. An editorial board of about 4 African physicists will be responsible for gathering, selecting, and composing the content of newsletter. An oversight board of about 3 people will provide mentoring and ensure publication deadlines are met.

The envisioned format of the newsletter is short items containing links to African national physical society websites, conference websites, larger documents, etc., giving fuller details. This format, but not necessarily the length, is illustrated in the two links:

http://www.epsnews.eu/wp-content/uploads/email/e-eps_march_2018.html and http://apps3.aps.org/email/wavefront/may12.html.

Particulars:

The newsletter will be distributed electronically and an international publisher sought. The publishing organization would maintain the subscription email list. The publisher would also maintain any documents linked to the newsletter. After 4 to 5 years, another organization, most preferably an African-based one, would assume the right and responsibility or else the newsletter will very likely cease publication.

Besides ensuring timely publication, the oversight board will also have the power to remove and appoint new members of the editorial board if an editor becomes unwilling or unable to meet responsibilities. This board will make the initial appointment of an editor-in-chief. This position will then rotate annually among the members of the editorial board. The oversight board will also serve as the liaison between the publisher and the editors. One eventual responsibility of the oversight board will be to help identify the new publisher and assist in the transition.

Initially, the editorial board would work with the publisher in creating an easy to use distinctive template of the newsletter. The editorial board will also develop and maintain a list of point of contacts in the different African nations. These physicists will help source the editors with news items from these countries. Besides standard items announcing conferences, schools, appointments, grants, novel research findings, noteworthy publications, etc., the editors can identify focus topics to highlight special developments. The editorial board may at its discretion appoint guest editors for these featured items. Each editor may appoint an assistant editor.

Status:

The initial publisher is being sought. The intention, in fact, is to present this prospectus to the APS's Committee on International Scientific Affairs (CISA) and to the APS leadership, soliciting their support for the distribution of the newsletter.

The following have agreed to serve on the oversight board:

- Prof. N. Chetty (University of Pretoria, Pretoria, South Africa) Vice President, IUPAP
- Dr. J. E. Gubernatis (Los Alamos National Laboratory, Los Alamos, New Mexico) Chair of the Physics in Africa Project; Member, Committee on International Scientific Affairs, American Physical Society
- Prof. A. Wagué (Dakar Cheikh Anta Diop University, Dakar, Sénégal) International Councilor, American Physical Society.

and the following have agreed to serve on the editorial board:

- **North**: Prof. M. Zghal (University of Carthage, Tunis, Tunisia)
- **South**: Prof. I. Gledhill (University of Witwatersrand, Johannesburg, South Africa)
- **East**: Prof. G. Amolo (Technical University of Kenya, Nairobi, Kenya)
- **West**: Prof. S. K. Danuor (Kwame Nkrumah University of Science and Technology, Kumasi, Ghana).

Besides representing North, South, East, and West Africa, these editors represent both the Francophone and Anglophone communities distinctive of different African nations.

Important mechanisms to tap the African physics community for contributions to the newsletter are in place. The first phase of the Physics in Africa project produced a point of contact list for 31 of the 54 African nations. These nations have about 90% of the population of Africa. The members of the editorial board have strong connections with 4 of the 5 largest physical societies in Africa, plus other activities and organizations such as the African Review of Physics and pan-African schools and professional societies, such as the African School of Fundamental Physics and Applications, the African School on Electronic Structure Methods and Applications, and the African Materials Research Society. The appointment of assistant editors will further broaden the connections.

Articles of interest from both the "Physics in Africa newsletter" and the Physics Comment will be referenced in future respective editions.

Opportunities

Vacancy: Editor-in-Chief South African Journal of Science

The Academy of Science of South Africa (ASSAf) is an independent statutory body of eminent South African scientists. ASSAf's primary objective is to generate evidence-based solutions to the problems and challenges facing South African society.

ASSAf seeks to appoint an Editor-in-Chief for the South African Journal of Science.

The South African Journal of Science (www.sajs.co.za) is an open-access, multidisciplinary journal published bimonthly by ASSAf. The Journal's mandate is to publish original research with an interdisciplinary and regional Africa focus and to provide a forum for discussion of news and developments in research and higher education.
The Editor-in-Chief leads an editorial team of ten disciplinary-specialist Associate Editors who are responsible for managing the peer review of submissions in their disciplines.

The Editor-in-Chief works closely with a full-time publishing team consisting of a Managing Editor, an Online Publishing Systems Administrator and an Online Publishing Administrator led by the Director of Scholarly Publishing. The Editor-in-Chief reports to the Executive Officer of ASSAf and is accountable to the Editorial Advisory Board.

This part-time, three-year contract position requires regular hours per week (16 hours) with some flexibility. Candidates can be based anywhere in South Africa and are not expected to work from the ASSAf office. The successful applicant will be required to enter into a three year Service Level Agreement with ASSAf.

Role

The Editor-in-Chief has overall responsibility for the editorial content of the journal – both scope and quality, and for the associate editors.

Tasks

- Act as ambassador of the journal and represent the journal through all interactions with users and on committees, specifically ASSAf's Committee on Scholarly Publishing and the Quest editorial board
- Set and drive the strategy of the journal –drive short- and long-term objectives
- Actively promote and grow the journal and enhance the reputation of the journal
- Determine and maintain editorial policies in conjunction with the publisher
- Work with the publisher to market the journal
- Lead the associate editor selection process, provide training/guidance to and oversight of associate editors; assign and balance review workloads
- Actively solicit manuscripts and value-added content such as book reviews and news items
- Oversee peer review and ensure continuous delivery of copy

- Write the Leader, or solicit Guest Leaders, for each issue
- Approve the final issue before publication
- Uphold policies of the journal and act as arbiter on disputes, appeals and cases of unethical conduct and conflicts of interest
- Review reports pertaining to metrics and performance
- Call and chair annual Associate Editor meetings
- Report on the journal to the Editorial Advisory Board

Professional attributes

- Active researcher, well known and well regarded
- PhD
- Broad knowledge of the subject fields
- Extensive networks across the subject fields
- Strong publication record
- Previous editorial experience, specifically in a decision-making capacity

Personal attributes

- Enthusiastic, energetic, highly motivated and committed
- Effective communicator
- Have a demonstrated vision for the journal and be able to communicate that vision
- Strong time management skills
- Strong leadership skills
- Ability to work effectively with diverse viewpoints and approaches
- Effectively delegate responsibility
- Effectively resolve conflict
- Firm decision-maker
- Fair and discreet
- Follow through promptly
- Explore and embrace innovative technologies and future directions in scholarly publishing

To apply, please submit a letter of application, a CV and the contact details of three references to Ms Lynette du Plessis at lynette@assaf.org.za before **14 January 2019**.

Correspondence will only be entered into with short-listed candidates.

ASSAf is an equal opportunity employer.
For more information contact Ms Lynette du Plessis at 071 687 5241.

LAAAMP Call

ICSU has awarded the International Union of Pure and Applied Physics (IUPAP) and the International Union of Crystallography (IUCr) a grant to enhance advanced light source (AdLS) and crystallography sciences in five targeted regions of the world: Africa, the Caribbean, Mexico, Southeast Asia and Middle East. Part of that funding will be allocated to send FAculty-STudent (FAST) teams for two (2) months during Calendar Year 2019 to LAAAMP's AdLS Collaborative Partners to participate in learning AdLS beamline techniques, including those involving crystallography.

APPLICATION CATEGORIES

Continuing

Consists of applications from FAST teams that are led by faculty who were 2018 New LAAAMP Awardees.

New

Consists of all other applications.

WHO IS ELIGIBLE?

Faculty

- Employed as a full-time faculty member at an accredited Ph.D. granting university that is located in Africa, the Caribbean, Mexico, Southeast Asia or the Middle East.
- Accompanied by one's Ph.D. student research advisee.
- Interested in using AdLSs to further one's research and training endeavors.
- Previous experience with using AdLSs is limited to a year or less.
- Ability to spend two (2) months during Calendar Year 2019 as a full-time visitor in residence at an AdLS that is a *LAAAMP*Collaborative Partner.

Student

- Registered as a full-time Ph.D. student at an accredited university that is located in Africa, the Caribbean, Mexico, Southeast Asia or Middle East.
- Accompanied by one's faculty research advisor.
- Interested in using AdLSs in one's dissertation research.
- Ability to spend two (2) months during Calendar Year 2019 as a full-time visitor in residence at an AdLS that is a *LAAAMP*Collaborative Partner.

AMOUNT OF FINANCIAL SUPPORT

LAAAMP will provide 1818 Euros per person to cover transportation costs. Any excess will be applied to accommodation and subsistence. The remainder of accommodation and subsistence should be negotiated with the host AdLS and other sources of support.

DELIVERABLES

Within one month after the conclusion of the visit to the host AdLS, the FAST team should provide the following:

1. Maximum 10-page description of the research conducted, including any publications that result. *All publications should acknowledge the support provided by IUPAP-IUCr LAAAMP within the ICSU Grants Programme 2016-2019.*
2. Maximum 3-page report that evaluates the non-scientific aspects of the visit, including positive experiences as well as ways that the visit could be enhanced in the future.

WHO ARE *LAAMP*'S ADLS COLLABORATIVE PARTNERS?

- Advanced Light Source (USA)
- Advanced Photon Source (USA)
- ALBA (Spain)
- Australian Synchrotron
- Canadian Light Source
- DELTA (Germany)
- Elettra (Italy)
- European Synchrotron Radiation Facility (France)
- Max IV Laboratory (Sweden)
- National Synchrotron Light Source-II (USA)
- Photon Factory (Japan)
- Pohang Accelerator Laboratory (South Korea)
- SESAME (Jordan)
- Siam Photon Source (Thailand)
- Stanford Synchrotron Radiation Lightsource (USA)
- Taiwan Photon Source

TO WHAT PERSONS AND EMAIL ADDRESSES SHOULD APPLICATIONS BE SUBMITTED?

RESIDENTS OF AFRICA

Professor Simon Connell

University of Johannesburg

Department of Mechanical Engineering Science

Faculty of Engineering and the Built Environment

Resolution Circle, 8th Floor, South Annex

cnr Empire Road and Barry Hertzog Avenue

Milpark, Johannesburg, 2006, South Africa

Email: shconnell@uj.ac.za

RESIDENTS OF THE CARIBBEAN

Professor Carlos R. Cabrera
University of Puerto Rico, Río Piedras Campus
Department of Chemistry
P.O. Box 23346
San Juan, PR 00931-3346
Email: carlos.cabrera2@upr.edu

RESIDENTS OF MEXICO

Professor Matías Moreno
Universidad Nacional Autónoma de México
Instituto de Física
Departamento de Física Teórica
Edificio Marcos Moshinsky , 2º p. C-250
Ciudad Universitaria, Coyoacán, C.P. 04510
México
Email: matias@fisica.unam.mx

RESIDENTS OF SOUTHEAST ASIA

Dr. Rungrueang Phatthanakun
Head of Research Facility
Synchrotron Light Research Institute (SLRI)
Muang District, Nakhon Ratchasima 30000, THAILAND
Email: rungrueang@slri.or.th

RESIDENTS OF THE MIDDLE EAST

Professor Özgül Öztürk
Department of Physics
Universität Siegen
Siegen, North Rhine-Westphalia
Germany
Email: ozgulkurtulus@gmail.com

Note: Final funding is dependent upon suitable arrangements being made with a LAAAMP AdLS Collaborative Partner.
Due date is 15 November 2018

For more info and how to apply: https://laaamp.iucr.org/calls/jan-dec-2019

African Light Source Conference 2019

The next African Light Source Conference will be held jointly with the Pan African Conference on Crystallography, in Accra, Ghana, early next year 28 Jan - 2 Feb 2019.

The vision is to have a light source in Africa.

The Conference Topics include: Medical Sciences, Heritage Sciences, Geosciences, Environmental sciences, Energy Sciences, Nano Sciences, Materials Sciences, Mineral Sciences, Accelerator and Detector Sciences, Competitive Industry, Capacity Building, Infrastructures, Strategy and Vision for the AfLS. There is some financial support for attendance based on the availability of funds and on the merits of the application, more details on the website.

The joint PCCr2-AfLS2 website is here: http://events.saip.org.za/event/AfLS2_PCCr2
and the Poster is here.

https://drive.google.com/file/d/1jEKBST4leXs_-Yu-wUhUI4wxYr7S8Ulp/view?usp=sharing
Download poster.

SAIP2019 Call for Abstracts

The 64th Annual Conference of the South African Institute of Physics will be hosted by The Department of Physics of the University of Venda at the Protea Ranch Resort Hotel in Polokwane (Limpopo).

The conference will run from 9 – 12 July 2019 and will be preceded on 8 July by Winter Schools on "Renewable Energy and Energy Materials" and "Condensed Matter."

Registration and abstract submission opens 11 January 2019. For more info and other important deadlines please visit the conference website: http://www.events.saip.org.za/event/saip2019

1st Call for Abstracts

The Department of Physics of the University of Venda will host the SAIP2019 conference at the Protea Ranch Resort Hotel in Polokwane.

The conference will run from 9 – 12 July 2019 and will be preceded on 8 July by Winter Schools on **"Renewable Energy and Energy Materials"** and **"Condensed Matter."**

Please note the following schedule:

Registration opens:	11 Jan 2019
Abstract submission opens:	11 Jan 2019
Abstract submission deadline:	11 April 2019
Notification of acceptance of abstracts:	8 May 2019
Early Bird Registration closes:	8 May 2019
Payment Deadline:	8 June 2019
Registration closes:	8 June 2019

All participants are kindly requested to keep to the schedule as indicated.

For all details, please visit the conference website at www.events.saip.org.za/event/saip2019

CONFERENCE PROCEEDINGS

The proceedings of the SAIP 2019 conference will be peer reviewed and produced in accordance with the DHET guidelines for recognition at the level of 0.5 units per article. Only papers that are submitted strictly on or before 23:59 SAST on 31 July 2019 will be considered for publication. The guidelines for authors, the application procedure for recognition of your article and other details relating to the proceedings will be available on the conference website.

Deadline for submissions for the March 2019 issue of Physics Comment is 15 March 2019

Physics Comment Editorial Policy

Physics Comment is an electronic magazine for the Physics community of South Africa, providing objective coverage of the activities of people and associations active in the physics arena. It also covers physics-related ideas, issues, developments and controversies, serving as a forum for discussion. It is not a peer review journal.

Physics Comment publishes innovative reports, features, news, reviews, and other material, which explore and promote the many facets of physics. Physics Comment endeavours to:

- support and inform the physics community
- promote membership of the South African Institute of Physics
- promote the understanding of physics to interested parties and the general public represent the readers'
- point of view
- focus on issues and topics of importance and of interest to the physics community

We accept submissions on any physics-related subject, which endeavours to inform readers and to encourage writers in their own researches. We aim to be politically, socially and geographically inclusive in the articles, which we commission and receive. Therefore, we shall not discriminate according to political or religious views. Physics Comment does not support or endorse any individual politician or political party. However, contributions, which are being published, may contain personal opinions of the authors.

It is our desire to present unfettered the opinions and research of our readers and contributors. All articles submitted for publication are subject to editorial revision. Such revisions, if necessary, will be made in cooperation with the author.

The views expressed in published articles are those of the authors and are not attributed to the Editorial

The Editor will make the final determination of the suitability of the articles for publication.

Declaration by Author

When an author submits material for publication, this means:

1. The author(s) assures the material is original, his/her own work and is not under any legal restriction for publication online (e.g., previous copyright ownership).
2. The author allows PC to edit the work for clarity, presentation, including making appropriate hypermedia links within the work.
3. The author gives PC permission to publish the work and make it accessible in the Magazine's archives indefinitely after publication.

The author may retain all other rights by requesting a copyright statement be placed on the work.

Authors should respect intellectual integrity by accrediting the author of any published work, which is being quoted.

Publication Deadlines

Physics Comment is published four times a year.

Issue	Closing Date	Publication Date
Issue 1	28 February	15 March
Issue 2	31 May	15 June
Issue 3	31 August	15 September
Issue 4	30 November	15 December

Specification and Submission of Content

Editorial Tone. As the voice of the physics community, the magazine will create a provocative, stimulating, and thoughtful dialogue with the readers; and provide a variety of perspectives that reflects the dynamism of the physics community.

Article types. The magazine is devoted to articles, reports, interesting facts, announcements and recent developments in several areas related to physics:

Manuscripts. Solicited manuscripts will be judged first for reader interest, accuracy and writing quality. The editor reserves the right to request a rewrite, reject, and/or edit for length, organization, sense, grammar, and punctuation.

Re-use. The publisher reserves the right to reuse the printed piece in full or in part in other publications.

Submission and Format. Manuscripts must be submitted to the editor on or before the designated due date Manuscripts must be submitted electronically, on the prescribed Microsoft Word template available for download from http://www.saip.org.za/PhysicsComment/. Manuscripts are to be

submitted directly to the editor: PhysicsComment@saip.org.za.

Style. AP style is followed for punctuation, capitalization, italics and quotations.

Photography and Illustration. All solicited photography and illustration should be part of an article and will be judged first for technical quality and editorial appropriateness. The editor and art director reserve the right to request revision or reject any material that does not meet their criteria. The publisher reserves full rights to all solicited photography and illustration, including the right to reprint or reuse graphic material in other publications.

Categories of Content Contributions

Technical articles and reports: These are generic articles of about 1 500 words plus diagrams and pictures. A technical article covers a relevant feature topic. Articles are authored by the writer and publishing a 40-word resume of the author could enhance its credibility. By submitting an article that has been previously published the author confirms that he/she has the right to do so and that all the necessary permissions have been received. The acknowledgement must be made within the article.

News: These are short editorial items usually not more than 250 words. Full-colour pictures must be clearly referenced on the editorial submission and on the picture or picture file.

Advertorials: Advertorials could be published when supplied by the client. We recommend a maximum of 500 words plus one or two pictures for maximum impact. A PDF file of the laid-out advertorial should be emailed to the client along with an MS Word file of the text and separate image files of the pictures. It is the client's responsibility to ensure that the advertorial is correct as it is, in fact, a paid for advert page.

Letters to the Editor: Letters to the Editor are encouraged. The Editor reserves the right to edit for length and format. The Editor will not change the political position of the initial letter. Physics Comment does not publish anonymous letters.

Advertising Policy: The Editorial Board will determine advertising prices for Physics Comment, subject to approval by SAIP Council. The objective will be to obtain revenue to maintain and develop the magazine. Physics Comment offers classified advertising to subscribers of the magazine for free. The advertisements must be a maximum of 60 words including the telephone number, and there is a limit of three free classifieds per subscriber, per issue. Advertisements may include a photo, which may be reduced in size or resolution by the editor to optimize loading time. All items or opportunities, which are being advertised for free, should be physics-related. The Editor reserves the right to refuse any advertising, which does not conform to the objectives of the magazine.

Submission of Articles

All articles must be submitted on the prescribed template available for download from http://www.saip.org.za/PhysicsComment/


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