Physics Comment

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Africa celebrates SKA bid outcome

Editor: Prof. Thomas Konrad

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Editor's Note

After nine years of intensive work on both sides, the race between Australia and South Africa for hosting the Square Kilometre Array (SKA), a radio-astronomical project worth 2 billion US $ is over. It ended with a compromise in favour of South Africa: roughly 2/3 of the total number of radio antennas will be erected in South Africa and its eight African partner countries – about 3000 mid-frequency radio dishes with the highest concentration in the Northern Cape but some of them as far away as Kenya or Madagascar (details can be found here). In this issue of *Physics Comment* we report on the celebration (page 4) of this outcome and communicate an official statement of the *SAIP*, which interprets "*the SKA as a game changer in the science and technology landscape*" of South Africa (pp. 5).

The success in the SKA bid would not have been possible without individuals who boldly believed a decade ago that a South African proposal could evolve to be able to compete with one from the more experienced Australian radio-astronomy community.

Let us not forget that South African physics has more to offer than fascinating radio astronomy. An article by Dr Hermann Uys from the National Laser Centre (NLC) in Pretoria (page 11) highlights a new development in the simulation of magnetic properties of large quantum systems by means of controllable trapped ions. While the corresponding experiments of this form of quantum computing were carried out at the National Institute of Standards and Technology in the US in collaboration with the NLC and other institutions, the NLC itself is setting up ion traps to contribute to this research area in the future. Prof Nigel Bishop from Rhodes University reports on the first workshop on Gravitational Wave Astronomy (GWA) that took place in South Africa and on a proposal to form a national centre for GWA (page 7). New insights into the decay of nuclei with implications for the question how chemical elements are formed in the universe are discussed by Dr Mathis Wiedeking of iThemba LABS on page 13.

I hope you enjoy this issue of PC!

With best wishes

Prof Thomas Konrad

Caption of picture on Front page: Cutting a celebratory cake, Minister Naledi Pandor, Minister Dr Siyabonga Cwele and Prof Justin Jonas. Credit: GCIS.

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

News from South Africa

SAIP2012 Important AGM Item – SAQA Professional Body Registration

by Brian Massara (SAIP office, Pretoria)

SAIP would like bring to your attention two important items members must prepare to discuss at the SAIP2012 AGM to be held on the afternoon of 13 July 2012, these are

- SAIP Registration with SAQA as a Professional Body and the
- SAIP Registration with SAQA of a Professional Designation

Background information can be found in the previous issue of the Physics Comment Magazine at http://www.saip.org.za/images/stories/documents/PC/PhysicsComment_March_2012.pdf.

Closed online discussion can be done in the secure membership area of SAIP members the link below; Please follow these steps

1. Go to SAIP website
2. Login to membership area
3. Copy and paste the link below into your address bar

https://www.saip.org.za/index.php/forum/9-membership-matters/14-saqa-registration-as-aprofessional-body

Africa celebrates SKA Bid Outcome

From Media release issued by SKA South Africa Project office

28 March 2012

Majority share of iconic telescope is coming to the African continent

"We have always said that we are ready to host the SKA, and the world has listened to us," Ms Naledi Pandor, South Africa's Minister of Science and Technology said at a crowded media briefing on 25 May 2012 in Pretoria, South Africa. She thanked her colleagues in government, South Africa's SKA team, partners across Africa and the many participating scientists and students for their excellent work over the last nine years that helped to secure the majority of the SKA for Africa.

I am ecstatic! I'm happy for our scientists, I'm happy for our country, I'm happy for Africa! We've done it! Who would have thought? I'm thrilled!" – Minister Pandor

Prof Justin Jonas, Kim de Boer and Dr Adrian Tiplady. Jonas is Associate Director: Science and Engineering at the SKA South Africa Project, De Boer is in charge of People Development and Support and Communications, and Tiplady is the Site Bid Manager. Credit: Loretta Steyn.

Since the announcement that South Africa, along with its eight SKA partner countries in Africa, will host the mid-frequency dish array and dense aperture array of the iconic SKA telescope congratulatory messages have been pouring in from around the globe praising the hard work of the South African SKA team and the unwavering support for Africa's site bid from the South African government.

Media representatives from newspapers, radio and television stations around the world attended the official briefing session in Pretoria, with many more joining the press conference via a video link to Cape Town. The announcement coincided with the celebration of Africa Day.

In their announcement, Members of the SKA Organisation acknowledged that Southern Africa was identified as the preferred site for the SKA by the independent SKA Site Advisory Committee, but added that the majority of the Members were in favour of a dual-site implementation model – an inclusive approach that was deemed to be scientifically justified, as well as technically and financially viable.

The next step for the SKA is a detailed design and pre-construction phase (2013 – 2015) followed by the construction of SKA Phase 1 – making up about 10% of the total instrument. Scientists should be able to use SKA Phase 1 for research by 2020. By that time construction on SKA Phase 2 should be underway (2018 – 2023) with full science operations commencing by 2024.

"Very relieved!" This is how Professor Justin Jonas, Associate Director: Science and Engineering, SKA South Africa, felt when he learned the outcome of the site bid. "We've been waiting for this decision for a very long time – it has been a long, hard road," Prof Jonas said. "Up to now the SKA project could not really move forward. At last we can now move into the really exciting phase – the detailed design and building of the SKA." Prof Jonas, who is also at the Physics Department at Rhodes University, has been a key role player in developing and defending South Africa's SKA site bid since 2001.

"The announcement that the major portion of the gigantic SKA telescope will come to Africa is a fantastic outcome for the continent," he said. "It maximises South Africa's scientific and engineering contribution and means that all the work we've done up to now – and everything we do from here onwards – will contribute to the SKA."

"I always knew that our bid was very competitive. After we were shortlisted for hosting the SKA in 2006, we worked even harder to fine-tune our site bid and we presented an exceptionally viable and robust implementation plan for the SKA."

"We chose our site very carefully – remote enough to do the science, but not so remote that infrastructure development and operations becomes too difficult and too expensive. These were deliberate and calculated decisions based on thorough analysis of the requirements of the SKA – and it paid off!" Professor Jonas is very excited about the implications of the SKA site decision for the role that South Africa's MeerKAT telescope will play in the future of the SKA.

"The decision recognises MeerKAT as a key instrument that will make up one quarter of SKA Phase 1 mid-frequency array, and the science planned for SKA Phase 1 is very similar to the MeerKAT science case – just much more ambitious," he explains. "Our researchers and students who participate in the MeerKAT surveys have a huge advantage. They are well placed to enter SKA Phase 1. They have the opportunity to become science leaders in future SKA projects."

Up to 2016 South Africa will be constructing the 64 MeerKAT dishes in the Karoo and construction on 190 SKA Phase 1 dishes should start more or less when MeerKAT is complete. "The design of the SKA dishes is not yet final, but they should look similar to the Gregorian-offset dish design chosen for MeerKAT," Prof Jonas expects.

More media releases and reports can be found on the SKA website.

Statement of SAIP on SKA Site

Prof Simon H. Connell (President SAIP)

The SKA and the South African Institute of Physics

The South African Institute of Physics welcomes the announcement that the Square Kilometre Array (SKA) project will go ahead with most of the telescopes based in South Africa and Africa.

The SKA has the capacity to address some of the most important and exciting major questions of astrophysics, which in fact have tremendous implications for a much wider area of physics. These questions relate to the nature of gravity, dark matter, dark energy, the physics of the early universe and

the possibility of life elsewhere in the universe. There are overlaps with particle physics, materials science and high performance computing. We also see opportunities in more technical fields, such as signal processing, communications, detector development and imaging. Several sectors in engineering, such as electronics, systems engineering and radar are in fact already participating through the MeerKAT project. Advances in all these technology areas will spread the benefits of the SKA ultimately to diagnostic medicine, environmental observation, the Internet and many other areas.

The SKA will build on South Africa's already impressive multi-wavelength Astronomy capacity, where many modes of observation can be coupled to observe the same system at the same time from a very similar perspective. This will leverage enormously the insight that can be gained into new or not yet understood phenomena. This capacity increases the chance of Southern Africa being yet further developed with exciting new instruments of astronomical observation. The SAIP therefore supports the bid for the next generation of gamma ray telescope, the Cherenkov Telescope Array (CTA), to be placed in Namibia. The CTA is to the Namibian High Energy Stereoscopic System (HESS) telescope what the SKA is to the MeerKAT array. The SAIP is involved in a project to develop Gravitational Wave Astronomy in South Africa. It is not hard to imagine that Southern Africa will become the world's astronomical "Mecca".

The training opportunities of the SKA are enormous. We particularly welcome the impact this will have on stimulating the interest of young South Africans in Science, in building the culture of learning and in building the perception that Africa is serious about innovation and excellence. The SAIP encourages young learners to choose a career in Science and Technology.

The SAIP is committed to playing its part to making this project a success. This will be in several contexts. We have mentioned the growth of the field of Astronomy, and the development of many synergies within Physics and technology generally. The SAIP will also facilitate the spin-off benefits to other fields, such as medicine and information technology. We will play our part to make sure the manpower development and outreach opportunities are maximized. Finally, the SAIP will leverage the advent of the SKA and participate in developing Science throughout Africa, through its partnerships with sister societies in Africa and the African Physical Society.

We see the SKA as a game changer in the science and technology landscape. It is a coup for our science system of a similar magnitude to the Large Hadron Collider at CERN. The results at CERN have pointed to an increasingly important symbiosis between direct discovery of new physics by creation of exotic particles in the laboratory and the indirect discovery of new physics by observation of the astronomical footprints of those same particles. In this sense, the very recent science developments have enhanced the scientific significance of the SKA project. We get a bigger bang for our buck. The SKA therefore also deserves the title of "New Physics Discovery Machine". The SKA project is one of the excellent examples that indicate the fruitful working relationships between scientists, scientific organizations and the Department of Science and Technology, which has played a key role in the scientific renaissance of South Africa.

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UCT Women in Physics Lunch

by Margie Maich (UCT, Capetown)

The UCT Women in Physics lunch took place on Thursday 17 May 2012. The lunch was attended by all UCT's female post-graduate students (three PhD and three MSc), as well as three third years and seven second years. The lunch was held at the UCT Club, with a buffet which appealed to all. The lunch was organised by Dale Taylor, one of the two female physics lecturers at UCT and physics secretary, Margie Maich. Three of the post-graduate students gave inspiring presentations. Andrecia Ramnath (MSc student) spoke about her visit to the Women in Leadership Conference in New York in first year and her upcoming

visit to the CERN Summer Student Programme. Razieh Morad (PhD student) told of her experience of studying physics in Iran, where female physics students are in the majority. Sherry Bremner (PhD student) enthralled the group with her description and photos of life at the South African National Antarctic Expedition, where she has done research on three summer visits. The Society of Physics Students chair, second year student Naomi van Jaarsveld, commented "The lunch created an environment where female physics students could be encouraged and learn from more experienced female physics students. It was a wonderful, fun experience."

Participants at UCT WiPiSA lunch

Razieh Morad spoke of her experience of studying physics in Iran

South Africa holds the first Workshop on Gravitational Wave Astronomy

by Prof Nigel Bishop – Rhodes University

The SAIP in collaboration with DST, NRF and LIGO international partners recently hosted a 2 day workshop on promoting Gravitational Wave Astronomy in South Africa.

Background

Laser Interferometer Gravitational Observatories (LIGO) have been operational since 2000, but at the sensitivity of the initial generation of instruments a detection was possible but not likely. Currently there are two LIGO facilities in the USA, as well as GEO and VIRGO in Europe. Construction of a detector in Japan has begun. Technology has been improving, and Advanced LIGO is scheduled to be online in 2014, although it may only be sometime later that design sensitivity is achieved. Once this happens, the most probable detection rate is many events per year. The era of gravitational wave astronomy will have arrived! Gravitational wave astronomy is a very broad field, encompassing hardware design, pulsar timings, data analysis, use of numerical and approximate methods in general relativity, and astrophysical modelling. Internationally, research in all these fields has become a growth area, but not in South Africa and Africa. For example, the LIGO Scientific Collaboration (LSC) comprises over 850 members from around the world, but has no members from Africa.

In September 2011 the National Society for Black Physicists in the USA invited the South African Minister of Science and Technology – Minister Naledi Pandor MP, to address its annual conference in Austin Texas. During her visit the Minister attended a breakfast meeting during which Prof Fred Raab from the LIGO Observatory made a presentation on Gravitational Wave Astronomy. At this meeting it was highlighted that other continents are actively involved in GWA but there was very limited participation from African countries. The minister then indicated that she would like to see an initiative to promote and grow Gravitational Wave Astronomy throughout Africa.

Group photo of the attendees of the workshop

Program

Reviews of the various aspects of GWA were given by six international speakers,

- Luc Blanchet, Institute d'Astrophysique de Paris, France
- Manuela Campanelli, Rochester Institute of Technology, USA
- Gabriela Gonzalez, Louisiana State University, USA, and Spokesperson for the LIGO Scientific Collaboration
- Luis Lehner, Perimeter Institute, Canada
- Fred Raab, Head, LIGO Hanford Observatory, USA
- Bernard Schutz, Director, Max Planck Institute for Gravitational Physics, Germany.

In addition, there were reports on current GWA activities at Rhodes University, Stellenbosch University and NITHeP, University of Cape Town, and University of KwaZulu-Natal. There was also a presentation by the Director of the Centre for High Performance Computing about the resources it can offer researchers in GWA.

Outreach

Dr Gabriela Gonzalez gave a public lecture entitled "Catching Einstein's Waves to See Black Holes" just before the workshop on 30 May 2012 at the Sci-Bono Discovery Centre, Johannesburg.

Attendees

There were a total of 64 delegates including 6 international speakers.The delegates were a mixture of academics and researchers, and research students. The South African institutions represented at the workshop were, African Institute for Mathematical Sciences, Centre for High Performance Computing, Council for Scientific and Industrial Research, Department of Science and Technology, Durban University of Technology, ESKOM, Hartbeeshoek Radio Astronomy Observatory, National Institute of Theoretical Physics, National Metrology Institute of South Africa, Rhodes University, Tshwane University of Technology, University of Cape Town, University of the Free State, University of Johannesburg, University of KwaZulu-Natal, University of Pretoria, University of South Africa, University of the Western Cape, University of the Witwatersrand, University of Zululand

Unfortunately, there were no delegates from Africa outside South Africa. Although the workshop was advertised throughout Africa, and there were some enquiries from other African countries, there was no financial support available for travel expenses.

Sponsorship

The organisers gratefully acknowledge financial support for the Workshop from

- Department of Science and Technology, South Africa
- National Research Foundation, South Africa
- Institutions in Canada, France, Germany and USA for supporting the airfares of the international speakers.

Way forward

The final session of the workshop was a general discussion about the way forward for GWA in South Africa and Africa. The meeting was informed that NITHeP (National Institute of Theoretical Physics) had confirmed funding for a "Chris Engelbrecht" summer school on GWA to be held 15 – 24 January 2013 at Rhodes University. It could be quite computational because CHPC had indicated willingness to provide training on the use of their facilities during the school. However, there are no specific plans or funding for GWA after that event.

A quick poll, by show of hands, was conducted to determine the degree of interest in the various branches of GWA. The results were

- Hardware: 2
- Data analysis: 3
- Numerical Relativity: 14
- Approximate methods: 5
- Astrophysics,electromagnetic counterparts: 9

It was agreed that the way forward would be to build on our current strengths, and then expand into neighbouring fields of GWA; and that numerical relativity is currently the strongest field of GWA in South Africa. A different type of strength that can be tapped is the support of the international GWA community. This means that there are opportunities, including partial funding from international sources, for South African academics and research students to visit international institutions, and also willingness by international academics and research students to travel to South Africa. Note, however, that the idea for South African students to pursue a doctoral degree overseas was not supported, because often such students do not return and there is no contribution to the establishment of local infrastructure.

Building on numerical relativity, the first target would be to develop activity in data analysis, because this would make it possible to join the LIGO Scientific Collaboration. Research on the various astrophysical aspects of GWA is already in progress in South Africa, and thus there is a root from which this activity can grow. Work on approximate analytic methods could develop as an off-shoot of numerical relativity, but it could also be started independently by a group working in mathematical relativity.

There remains to consider the field of hardware, i.e. the design and construction of a LIGO facility. The difficulties with this field are that, in terms of the poll given above, it has the lowest interest; and that it is by far the most costly, e.g. a 3rd generation facility is estimated to cost at least US$400 million. Even so, there are good reasons why South Africa should develop expertise in the field. The first point is that the expertise could be in only certain components of a detector, i.e. South Africa could be involved without building a whole detector. Secondly, the extraction of scientific information from detectors is greatly enhanced if they are evenly distributed across the globe. At present there are not even any plans for a detector in the southern hemisphere. There is therefore the possibility that considerable international support could be obtained. Finally, international plans for 3rd generation detectors would be on a timescale of 2020 at the earliest, so a financial commitment would not be needed until then.

As remarked earlier, internationally GWA is a well-developed and growing field of scientific research, but activity in South Africa is quite limited. Further GWA complements government initiatives in astronomy particularly multi-messenger. In order for the field to develop in South Africa, it needs seed funding. We

propose the establishment of some form of national centre, with funding for three years to cover research students and postdocs, admin support, partial secondment of the director, and running expenses. The national centre could be a node of NITHeP, or an NRF Centre of Excellence, or some other structure. The national centre should have a director who would report to a board with national and international members. The mandate of the national centre should be to develop GWA, in all aspects, nationally. In particular, this means that although some of the funding could be used to support students at the host institution, a significant portion would be reserved for students elsewhere. An early task for the national centre would be to commission a geological report on the suitability of sites in South Africa to host a LIGO facility.

The meeting elected a working group to engage with government about implementation of the above proposal, comprising:

- Nigel Bishop (Rhodes University).
- Jeandrew Brink (NITHeP-Stellenbosch).
- L. Combrinck (HartRAO).
- Sunil Maharaj (University of KwaZulu-Natal).
- Denis Pollney (Rhodes University).

Immediate Follow-Up Activity

"Chris Engelbrecht" summer school on GWA to be held 15 – 24 January 2013 at Rhodes University.

Medals and Honours

by Thomas Konrad (UKZN, Durban)

Dr Patience Mthunzi

- The Order of Mapungubwe: Bronze has been bestowed upon a South African scientist, Dr Patience Mthunzi from the *Council for Scientific and Industrial Research (CSIR)*, for outstanding contribution in the fields of biochemistry and biophotonics. Dr Mthunzi works in the field of optical tweezing which enables to separate non-invasively sick cell's from healthy ones by means of infrared laser light with possible applications in cancer treatment. More information can be found in the corresponding Media release of the *CSIR*.

- Prof Martial Ducloy was elected Foreign Member of the Russian Academy of Sciences due to his achievements in the field of coherent optics, laser physics and laser spectroscopy as well as his long-lasting collaboration with Russian institutes. Prof Ducloy, a former president of the *European Physical Society (EPS)* and the *French Physical Society*, played a profound role in support of South African Physics through *EPS* as well as the International Union of Pure and Applied Physics. In particular he contributed to the development of Physics in SA as a member of the international panel for *Shaping the Future of Physics*.

Physics 500

By Brian Masara (SAIP office, Pretoria)

The Physics 500 Project aims to identify and track physicists in Industry. The purposes of the project are to:

- Identify industries in South Africa that employ physicists,
- Identify physicists working in South Africa,
- Use this information to promote physics,

- Promote collaboration between the SAIP and industry.

For more information, visit the project website at: http://www.saip.org.za/physics500/login.php

SA Physics Graduates Database

By Brian Masara (SAIP office, Pretoria)

If you have a degree in physics and you are currently working, studying or unemployed and resident in South Africa, or have studied physics in South Africa we kindly request you to sign up and give us your personal statistics. We need you! The statistics we collect, with your help, will be used to influence legislation, decision-making and all matters related to physics funding required for training more physicists.

Read more details on confidentiality and great benefits of signing up and updating your details

http://graduates.saip.org.za/background.php

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For enquiries contact SAIP Office at info@saip.org.za

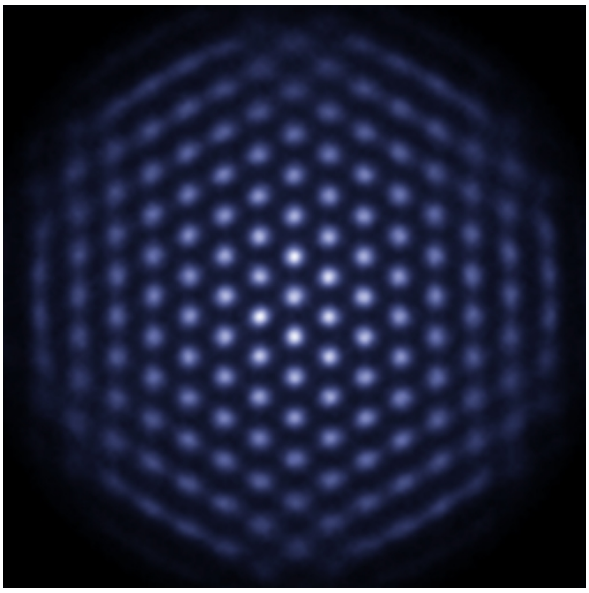
Articles

Ion Trap Quantum Simulation Enters Computationally Relevant Regime

by Hermann Uys (CSIR, Pretoria)

Hilbert space is a big place

Hilbert space is a big place. Any quantum physicist doing many-particle physics quickly comes to terms with this inconvenience. Try to store the density matrix of a simple system of 30 two-level particles and you find out that even modern supercomputers, the likes of Japan's K computer, China's Tianhe-1, or the USA's Cray Jaguar run out of memory. Cognizant of this dilemma, physicists have long since proposed (commonly attributed to Richard Feynman) that one solution is to use particles that are themselves quantum mechanical in nature, in a computational device that models quantum systems, that is, build a quantum simulator. This goal is actively being pursued in a number of technologies from photonic systems [1] to ultra-cold neutral atom gases [2].



Top-view fluorescence image of pancake-shaped crystal of beryllium ions used in the quantum simulator. The image diameter is about 300 micron. Image provided by the NIST ion storage group, Boulder, Colorado, USA.

Enter ion traps

Now, in a recent article published in the journal Nature [3], a team of physicists from the National Institute of Standards and Technology in the United States, the University of Sydney in Australia, and the CSIR in South Africa, claim they can simulate quantum magnetism with trapped atomic ions in a regime beyond the grasp of classical computers. In their experiment the quantum simulator consisted of about 350 beryllium ions

trapped in the static magnetic and electric fields of a Penning ion trap. The ions were laser cooled down to a temperature of about a millikelvin. At these temperatures the ions crystallize into a pancake-shape a fraction of a millimeter in diameter and a single atomic layer thick. This pancake of ions forms the heart of the quantum simulator.

Simulating quantum magnetism

The experiment aimed to simulate the Ising model interactions of quantum magnetism. In the simulator, two internal hyperfine levels in each ion represent the spin-up and spin-down components of the spins in an Ising model. The challenge is to then engineer spin-spin interactions between the ions. The researchers accomplished this by using lasers to exert precisely tuned optical-dipole forces on the ions, so that they start to oscillate inside the trap. Because the ions are charged, they repel each other, and as a consequence share collective modes of motion in the trap. In fact, the way the ions in the pancake structure move collectively, is very similar to the modes of motion of the head of a drum. The experiment is so designed that the direction in which an ion experiences a force due to the laser fields depends on whether its spin points up or down. In this way, the magnetic character of each ion is coupled to the magnetic character of every other ion through their collective motion inside the trap, and thereby mimics a magnetic interaction. If you do it right, this system behaves exactly like a quantum magnet.

The experiment served to benchmark the capabilities of ion trap quantum simulators by focussing on analytically solvable regimes first. This step is crucial in building confidence in the method once the simulator tackles problems that are intractable on classical computers. The team further demonstrated that both the strength and range of the interaction can be manipulated. The experiment represents a landmark in ion trap quantum simulation, because the number of particles in the simulator is about twenty times larger than that achieved in earlier attempts [4], and about ten times larger than what can be handled by any supercomputer. Ultimately the researchers hope to directly observe strongly correlated condensed matter phenomena such as spin-liquids and their quantum phase transitions [5]. To advance the experiment beyond the benchmarking stage, several improvements are in the pipeline to overcome challenges such as the unwanted effects of decoherence.

The quantum simulation experiment was carried out at the Boulder, Colorado site of the National Institute of Standards and Technology (USA) in the laboratory of Dr. John Bollinger. The CSIR is currently constructing an ion trap laboratory in their National Laser Centre and invites M.Sc. students with an interest in the applications and fundamentals of quantum technologies to **submit applications for Doctoral level studies at**

http://www.csir.co.za/vacancies/pdf/2012/Advert Ref_301173_Doctoral Studentship.pdf

or contact Dr. Hermann Uys directly at mailto:huys@csir.co.za.

You can download the Nature article following this link
http://www.nature.com/nature/journal/v484/n7395/full/nature10981.html

Read a non-technical opinion piece here: http://www.nature.com/nature/journal/v484/n7395/full/484461a.html

And see the NIST press release here: ***http://www.nist.gov/pml/div688/qubits-042512.cfm***

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Author Biography: Dr. Hermann Uys holds a Ph.D. in theoretical quantum optics from the University of Arizona, Arizona, USA. His interested in quantum control of trapped ions started during his post-doc in the ion trapping group of Dr. John Bollinger at the National Institute of Standards and Technology in Boulder, Colorado, USA. Currently he runs Laboratory for Quantum Control of Atoms and Molecules (MAQClab) at the National Laser Centre of the CSIR in Pretoria.

Scientists looking to the very small to solve one of the great questions of physics

by Dr. Mathis Wiedeking

"How were the heavy elements from iron to uranium made?" Discover magazine identified this as one of the greatest unsolved questions of physics in February 2002. Many of the elements are believed to be produced in stars and supernovae throughout the universe. Now, scientists have come one step closer to answering this question.

The 18-member team from seven US American, South African, and European laboratories and universities was led by Dr. Mathis Wiedeking of iThemba LABS (South Africa) and Lawrence Livermore National Laboratory (California, USA). The scientists, for the first time, independently confirmed the existence of an enhancement feature in the decay pattern by investigating the radioactive disintegration of nuclei. Just as for many scientific discoveries, the existence of this enhancement has been the topic of a decade-long debate in part because it would dramatically alter the production of the elements in the hot and dense cosmic environments where they are made.

The team's observation followed an experiment where particles were smashed together to create new nuclei. The decay products from these nuclei, such as gamma radiation which originate from deep within them, are then studied using arrays of advanced detector systems. From this a wealth of information can be extracted such as the effects that influence overall reaction rates in astrophysical environments which are present during a supernova event.

The observed feature manifests itself through an increase in the ability of nuclei to absorb and emit light characteristic of the environments where the elements are formed. With the existence of the enhancement now confirmed, it has become clear that laboratory-based experiments must occur in the same settings as where they take place in the cosmos if they are to best answer the question of how the elements are formed.

To pursue this goal the international team of scientists will perform experiments using tiny pieces of star matter which is created using the world's most energetic laser at the National Ignition Facility at Lawrence Livermore National Laboratory in California. The information garnered from these experiments, may significantly improve our understanding of the elemental abundances observed here on earth and elsewhere in the universe. The results were published in Physical Review Letters (Vol.108, No.16, #162503) by the American Physical Society.

For more information please contact Dr. Mathis Wiedeking at wiedeking@tlabs.ac.za

Author Biography: Having *grown up in the southern part of Germany I moved to the United Kingdom to pursue my undergraduate degree in physics at the University of Surrey. After graduation I started my postgraduate studies at the Florida State University in Tallahassee (USA) under the supervision of Prof. Tabor. At FSU I completed the M.S. in Physics and received the doctoral degree in 2005. As a post-doctoral researcher at Lawrence Berkeley National Laboratory (California) I initiated and developed an experimental program to study light neutron-rich nuclei in fusion reactions. The program has been very successful in measuring lifetimes of excited states in neutron-rich nuclei and addressed the heavily debated question on the existence of a unique matter distribution in 16C. In 2008 I began my appointment at Lawrence Livermore National Laboratory (California) where I led an effort to measure nuclear decay properties from the region of high-level densities (quasi-continuum) to individual discrete levels by analyzing statistical gamma-ray cascades. Besides the fundamental science aspect this work is of importance to the applied nuclear science program at the National Ignition Facility. When not at the laboratory thinking about nuclei and their*

properties I am taking to the skies as a pilot holding a PPL certificate. My wife Amber and I are excited to explore the beautiful country of South Africa and its neighbours from the air and the ground in the years to come.

Recognising and addressing changes in first-year university students' knowledge and skills

by Prof Diane Grayson - University of Pretoria

First year lecturers have been bemoaning the low level of understanding of their students for years. Comments like, "the students are getting weaker every year" are common. But in the past few years evidence suggests that students really are getting weaker in a number of specific and alarming ways. 2009 marked a turning point. This was the year in which the first group of students who had written the new school-leaving qualification, the National Senior Certificate (NSC), entered South African universities.

Figure 1 shows the distribution of marks in Mathematics and Physical Sciences for students who were accepted into the BEng degree at the University of Pretoria in 2008 and 2009. The 2008 cohort wrote the Senior Certificate (SC) and the 2009 cohort wrote the NSC. While the distribution of marks in Physical Science did not change a great deal from 2008 to 2009, there was a very large change in the distribution of marks in Mathematics, with the marks clustering above 80%. Since a whole cohort of over 1000 students cannot suddenly become smarter than their predecessors, these marks were a cause for concern.

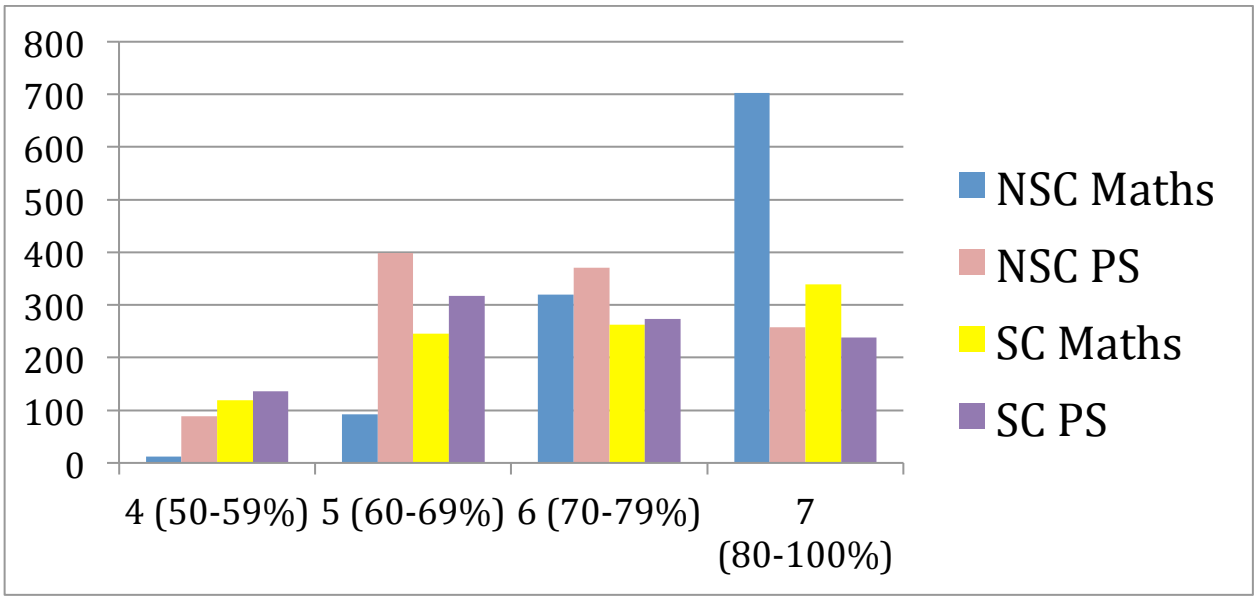

Figure 1: Grade 12 results in Mathematics and Physical Sciences for first year BEng students in 2008 (N=974) and 2009 (N=1134)

In 2009 two members of the University of Pretoria's Mathematics Department, Johan Engelbrecht and Ansie Harding [1], analysed the performance of the first year engineering students in their first semester calculus module (Figure 2). Given the differences in the distribution of marks in the NSC examination and the calculus module, the results suggest that in 2008 the NSC Mathematics examination did not sufficiently differentiate among students with different levels of understanding and competence in mathematics. Areas of weakness included algebraic manipulation, graphical interpretation, factual knowledge and concept application, although there was a marked improvement in the last three of these areas as the semester progressed.

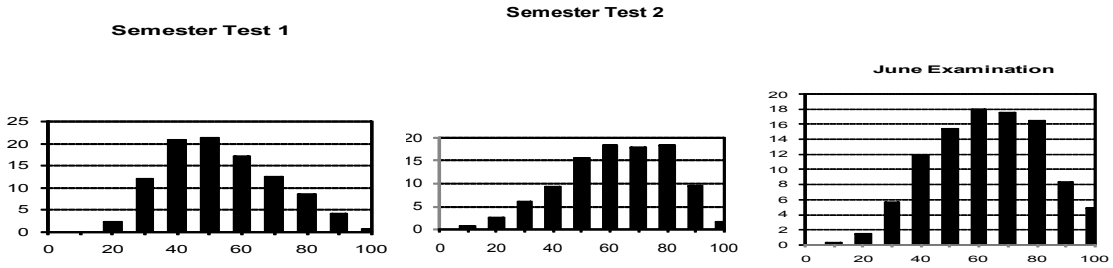

Figure 2: Performance of 2009 cohort of BEng students in first semester Calculus.

In an analysis of the November 2008 NSC Mathematics examination papers, Umalusi [2] found that the level of cognitive demand was similar to that of the Standard Grade (SG) Mathematics papers of the SC from 2005 to 2007, and much lower than that of the 2005-2007 Higher Grade (HG) papers (Table 1).

Table 1: Composition of Mathematics examination papers in the school-leaving examination from 2005-2008

Exam	Knowledge and routine procedures (%)	Complex procedures and problem-solving (%)
Average of 2005-2007 HG papers 1 and 2	52	48
Average of 2005-2007 SG papers 1 and 2	73	27
NSC November 2008 papers 1 and 2	72	28

Analysis of the pass rates of the 2009 entering BEng students in their first semester modules showed that there was a decrease of 10-15% compared with the 2008 students' results. In Calculus students must pass the first semester module in order to register for the second semester module. In 2009 only 85% of students managed to do this after three attempts (examination, supplementary examination and winter school), compared with 97% of the students enrolled in 2008.

From informal discussions with first-year lecturers there is a consensus that since 2009 incoming students' basic mathematical skills in algebra, trigonometry and even arithmetic are worse than before. Ironically, the new Grade 10-12 Physical Sciences curriculum introduced in 2006, which was supposed to focus more on conceptual understanding, seems to have led to students being even more eager to merely plug numbers into equations than before.

In my work with in-service teachers I have tried to find out the cause of these problems. Recently I have been asked to speak to groups of teachers from independent schools.

One serious problem I have uncovered is that the way the Physical Sciences examination is marked encourages bad problem-solving practice, both in government and independent schools exams. Last year, when running a workshop for 80 teachers, I showed the teachers a problem-solving procedure that included rearranging the relevant equation to make the unknown quantity the subject and then substituting numerical values for the known quantities. There was a great uproar in the room. After calming everyone down I discovered that in the examination learners are given marks for FIRST substituting the numerical values into an equation and THEN rearranging and solving for the unknown. I have spoken to an examiner and a number of teachers about this poor practice and the answer is the same—learners' algebraic skills are so poor that if they have to do the algebraic manipulation first they risk losing too many marks. So instead of addressing the problem by improving learners' algebraic skills, the education system is working around the problem.

Another examination-related problem is that multi-step problems have, for the most part, been removed from the Physical Sciences examinations. That means that although the content addressed in the questions may be the same, the cognitive demand is lower because students are told which steps to follow in which order.

A third problem I have encountered is that many teachers are teaching recipes and pattern matching. I have seen learners' notes where the teacher has told them, "If it's problem type A, follow these five steps; if it's problem type B, follow these 3 steps". No conceptual understanding, no problem-solving, no thinking required. When I ask students with high matric marks who end up in my office because they are failing what went wrong, the universal lament is that their teachers' spoon-fed them rather than teaching them to think for themselves.

Lastly, I have discovered that many learners do very little homework or exam preparation.

The net result of these problems is that we are taking in students at university who have done well on examinations that are not very demanding in terms of understanding, problem-solving skills or mathematical facility. Good, but not necessarily exceptional, students are able to obtain very high marks with little effort, leading them to think that they are brilliant. On the other hand, because they did not have to work hard at school, they do not know how to work hard, lacking both physical and intellectual stamina.

So what can we do? First, recognise the problems and address them. At the University of Pretoria we have extended degree programmes in science and engineering in which students do focus on conceptual understanding, problem-solving skills and developing facility with basic mathematics. They also learn to work long and hard. Second, influence the examiners to promote sound approaches to problem-solving. Third, work with teachers to improve their understanding of Physics. SAIP is about to embark on a project to develop Physical Science teachers, which will help to provide a long-term solution to the problems we are seeing.

References:

[1] Engelbrecht, J and Harding, A. Paper presented at the Mind the Gap Forum of the Academy of Science of South Africa, 21-22 October 2010, Cape Town.

[2] Umalusi. 2008 Maintaining Standards Report. Part 3: Exam Paper Analysis. Pretoria: Umalusi, May 2009

Opportunities

Post-Doc Opportunity at UKZN NITheP

The KZN node of the South African National Institute for Theoretical Physics (NITheP) has one postdoctoral vacancy in the field of Open Quantum Systems and Quantum Information Processing and Communication. The appointment will be made within the structure of the University of KwaZulu-Natal on a two-year contract basis, with the possibility of renewal for one additional year.

Duties: Maintaining a vigorous research programme being involved with supervision and tutoring at graduate level.

Commencement of duties: 1 October 2012 or as soon as possible thereafter ``.

Closing date: Review of applications will begin on 31 July 2012 and continue until the position is filled.

Enquiries: Prof Francesco Petruccione on +27 31 260 2770 or at petruccione@ukzn.ac.za Webpage: http://www.nithep.ac.za and http://quantum.ukzn.ac.za/

Applications must include a complete CV, publication list, description of present and future research interests and copies of relevant degree certificates. Applications to be e-mailed to mncubene@ukzn.ac.za

Post-Doc Opportunity at Stellenbosch NITheP

The Stellenbosch node of the South African National Institute for Theoretical Physics (NITheP) has two postdoctoral vacancies in the fields of Condensed Matter and Statistical Physics. The particular research focuses of this node are cold atoms, quantum transport and phase transitions. The appointments will be made within the structure of Stellenbosch University on a two-year contract basis, with the possibility of renewal for one additional year.

Duties: Maintaining a vigorous research programme and being involved with supervision and tutoring at graduate level.

Requirements: A relevant doctorate of high standing and a developing research record and demonstrated research potential.

Commencement of duties: 1 September 2012 or as soon as possible thereafter.

Closing date: Review of applications will begin on 31 July 2012 and continue until both positions are filled.

Enquiries: Prof Frederik Scholtz on +27 21 808 3871 or at fgs@sun.ac.za **Webpage:** http://www.nithep.ac.za

Applications must include a complete CV, publication list, description of present and future research interests and copies of relevant degree certificates. Applications to be e-mailed to renekotze@sun.ac.za

Doctoral Studentship: Ion Trapping and Cooling for Quantum Technologies

The CSIR National Laser Centre is searching for an outstanding Doctoral candidate with an interest in either experimental or theoretical quantum mechanics to advance our ion trapping project. Ion traps are designed to trap single, isolated (ionized) atoms and study fundamentals and applications of their quantum dynamics.

Click here for more information and how to apply
http://www.saip.org.za/index.php/news-and-events/opportunities/177-doctoral-studentship-ion-trapping-and-cooling-for-quantum-technologies

Upcoming Conferences & Schools

SAIP2012 Annual Conference

Abstract submission and registration is now open for the 57th Annual Conference of the SA Institute of Physics which will be held from 9 -13 July 2012. The 57th SAIP Conference will be hosted by the University of Pretoria on the main campus.

1) Donwload the Call for Abstracts at

http://indico.saip.org.za/getFile.py/access?resId=1&materialId=0&confId=14

2) To register and submit your abstract visit the SAIP 2012 website at
http://indico.saip.org.za/conferenceDisplay.py?confId=14

World Conference on Physics Education 2012

The World Conference on Physics Education will be held in Istanbul, Turkey in July 2012. The conference is aimed at physics educators, teachers, researchers, and policy makers. For further information please visit their website at: http://www.wcpe2012.org/

African School of Physics 2012, Ghana

We would like to inform you about the 2012 African School on Fundamental Physics and its Applications. The school will be held on 15 July - 4 August 2012 at the Kwame Nkrumah University of Science and Technology (KNUST) Kumasi, Ghana
For more information visit http://africanschoolofphysics.web.cern.ch/africanschoolofphysics/

IONS-AFRICA 1: Fibre and Quantum Optics, South Africa

DATE: 31 August - 02 September 2012
VENUE: Cathedral Peak Hotel, Drakensberg, South Africa
TOPICS: Fibre and quantum optics

The Council for Scientific and Industrial Research (CSIR) Student Chapter is hosting the first IONS in Africa. IONS-Africa1 will take place from Friday 31st August to Sunday 2nd September at Cathedral Peak Hotel in the Drakensberg, KwaZulu-Natal, South Africa.

The conference is geared primarily towards Honours, Masters and PhD students from Africa who study in an optics-related discipline. Although the conference will be centred around fibre and quantum optics, all research areas in the field of optics and photonics are welcome.

Please visit the website for more information:

http://www.ions-project.org/index.php?id=4&topic=ionsafrica1

Quantum Africa 2

The 2nd conference in the Quantum Africa Series will take place from the 3rd to the 7th September 2012 at Mount aux Sources Hotel in the Northern Drakensberg, South Africa.

Topics: Controlling quantum dynamics, open quantum systems, quantum computing and communication, quantum cryptography, quantum metrology, quantum biology, quantum foundations, quantum information theory, quantum materials, quantum optics, spintronics.

Plenary Speakers:

F. Jelezko (University of Ulm)

N. Gisin (University of Geneva)

A. Ekert (National University of Singapore and University of Oxford)

M. Padgett (University of Glasgow)

L. Davidovich (Universidade Federal do Rio de Janeiro)

Sir P. Knight (Imperial College) - To be confirmed

Invited Speakers:

A. Bassi (University of Trieste)

A. Buchleitner (University of Freiburg) - To be confirmed

B. Hiesmayr (University of Vienna)

W. Loeffler (University of Leiden)

N. Lutkenhaus (University of Waterloo)

M. Mosca (University of Waterloo)

J. P. Paz (University of Buenos Aires)

T. Ralph (University of Queensland)

W. Schleich (University of Ulm)

S. Severini (University College London)

P. Villoresi (University of Padova)

A. Winter (University of Bristol) - To be confirmed

Webpage:
http://quantum.ukzn.ac.za/events/quantum-africa-2

7th International Conference On Laser Induced Breakdown Spectroscopy Luxor - Egypt

The 7th International Conference on Laser Induced Breakdown Spectroscopy will be held in Egypt from 29 September - 4 October 2012

Registration and Call for papers: We are inviting oral/poster presentations and commercial exhibits

Deadline of abstracts submission is May 15, 2012

For more information, online registration and abstracts submission please visit

http://libs2012-niles.org/

6th International Conference on the frontiers of Plasma Physics and Technology

4-8 March 2013, Gaborone, Botswana

We are pleased to organize the "6th International Conference on the Frontiers of Plasma Physics and Technology" in Gaborone, Botswana during 4-8 March 2013. This is the sixth conference in the series and the earlier conferences were held in India (Bangalore-2002 and Goa-2005), Thailand (Bangkok-2007), Nepal (Kathmandu-2009) and Singapore (2011). Success of the preceding conferences has given us a deeper satisfaction and encouraged us to move beyond the borders of Asia and establish an alliance with African countries.

Emphasis of the conference will be on all the frontier topics of plasma physics and technologies, and classified in the following three categories but not limited to.

1. Fundamental plasmas: Advances in plasma sources, plasma diagnostics, astrophysical, cosmic and space plasmas, condensed and extreme state matter, high energy density matter, laboratory astrophysical, planetary, supernova, turbulent plasmas, etc.

2. Innovative trends in Applications and Technologies: Advances in particle /photon acceleration, Lasers, Nanotechnologies, Novel radiation sources and applications in Biology, Chemistry, Environment, Health, Industries, Safety, etc.

3. Advances in Nuclear Energy: Development of ultra-laser pulses, Laser-plasma interaction, Magnetically confined plasmas, Inertial fusion plasmas, Nuclear physics under transient state, Recent progress in Fusion studies, Target and reactor physics, Unconventional energy sources, Z pinch, Hybrid (fission plus fusion) reactors etc.

Some of the confirmed speakers include; Beg F. (USA), Borghesi M. (UK), Cvelbar U. (Slovenia), Deutsch C. (France), Fedosejevs R. (Canada), Fortov V. (Russia), Fryxell B. (USA), Gericke D. (UK), Hoffmann D. (Germany), Jain P.K.(Botswana), Jaroszynski D. (UK), Jean Paul-Perin (France), Kong H.J. (Korea), Malka V. (France), Mckenna P. (UK), Mendonca J.T. (Portugal), Mulser P. (Germany), Murakami M. (Japan), Neely D. (UK), Ozaki. T. (Canada), Patel P. (USA), Pegoraro F. (Italy), Perlado M. (Spain), Riconda C. (France), Sakagami H. (Japan), Sharkov B. (Germany), Soto L. (Chile), Stehle C. (France), Ulrich A. (Germany), Oost V. G. (Belgium), Varandas C. (Portugal), Walter R. (USA), Wintner E.(Austria), Zvorykin V. (Russia) etc.

We cordially invite all the researchers working in the above and related topics to participate in

the conference. For scientific information please contact Tara Desai on: fppt@fppt-series.com or P.K.Jain jainpk@mopipi.ub.bw

International Conference on Optics and Lasers Applications ICOLA2013

Optics and laser technology is a fast growing technology, which has wide range of applications in all the branches of science and engineering. Optics and laser applications are used in medicine, agriculture, energy and mines, defense, computers, industries, and entertainments. Recently the University of Namibia started the Faculty of Engineering and Information Technology at the northern campus in Ongwediva with the blessings of the Government of Namibia. The faculty is equipped with latest available equipment and technology in the world. The faculty has several departments and all the departments have highly specialized experts hired from all over the world. We wish to share the excellent existing facilities and expertise of UNAM with rest of the world to further advance the knowledge in the relevant fields of lasers. Therefore, we will organize an international conference on optics and laser applications (ICOLA2013) in 2013 from July 9 to 12, 2013, during the best climatic conditions of Namibia in Windhoek.

For more information and how to register click here http://www.unam.na/icola2012/index.html

Deadline for submissions for the September 2012 issue of Physics Comment is 31August 2012

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:

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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 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.

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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. 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 by 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.

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Submission of Articles

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