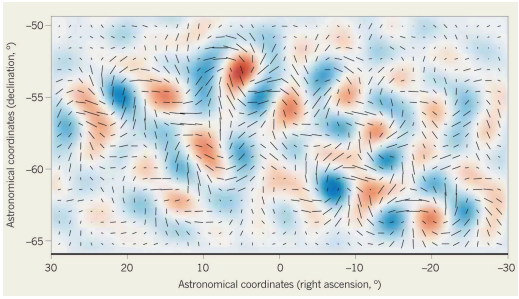
Vol 6, Issue 2, June 2014 Webpage Email

Physics Comment

A Southern African Physics Magazine

Can we weather sun storms?

A Quarterly Newsletter Issue No 2- Winter



Editorial board: T. Konrad and A.D.M. Walker

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Editor‘s Note

The book of nature is written in the language of mathematics. This statement is often attributed to Galileo Galilei, but the concept has been the subject of contemplation by philosophers and scientists since Pythagoras’ times (6th century BC). It seems justified judging by the amazing success of modern science based on mathematics. Take for example, the reconstruction of the evolution of the early universe by analysing the information contained in the cosmic microwave background (CMB) radiation. Dr Moumita Aich from the Astrophysics & Cosmology Research Unit at UKZN in Durban unfolds for us, on page 12, the exciting, ongoing story of discovery, which is fueled by recent evidence of primordial gravitational waves caused by an exponential cosmic expansion. The survey of the galactic foreground radiation, necessary to distinguish the CMB from it, will involve a local telescope. This 7.6 m antenna, was recently erected at the Klerefontein support base of the South African MeerKAT telescope.

This issue of Physics Comment also features an article by Mrs Catherine Webster from SANSA on the monitoring of sun activities by the only Space Weather Regional Warning Centre in Africa. In addition, Prof Derck Smit (UNISA) reports on a new virtual centre that allows us to share atomic and molecular data world wide.

Why is the mathematical description of nature so successful? According to philosopher Emmanuel Kant, because it is not *nature* itself but rather our *perception* of it, which we are describing, and this perception is linked to how we think, anyway. What is your opinion?

You can let me know when we meet soon at the SAIP conference.

With best wishes
Prof. Thomas Konrad

Caption of picture on cover page: Artist’s impression of coronal mass ejection from the sun (NASA)

Physics Comment is a journal 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.

News from South Africa

Mathematics and science education conundrum in South Africa

Physicists call for better teacher training

SAIP Press Release

So the Executive Opinion Survey of the World Economic Forum ranked South Africa's science and mathematics education last out of the 148 economies surveyed and the SA Department of Basic Education is ambivalent about the ranking.

"Are we going to spend our energy on fighting each other on this or agreeing on workable interventions?" said Dr Igle Gledhill, President of the South African Institute of Physics (SAIP). "Let's get on with coordinating effective actions and solving the problems." In a review of undergraduate physics teaching and learning, SAIP found that university departments agree unanimously on the poor level of preparedness of students entering first-year physics. This is disastrous for a country where so much depends on geology, mineralogy, chemistry, and technology. Health professionals, engineers and technologists require training in physics by virtue of its nature as a fundamental discipline.

SAIP has advocated for a well-structured long-term teacher professional development programme ideally suited to adequately cater for the critical professional development needs of teachers. Even experienced teachers can gain from constructive peer coaching and innovative mentorship programmes. It has become evident that university physics departments should play a pivotal role in teacher training in order to turn the tide against inadequate physics mastery and collaborations between education and science faculties are already starting to crystallize.

SA's science and mathematics education system can immensely benefit from a vast array of possible innovative interventions. There are individual initiatives in tutoring and usage of science kits up to the level of engagement in writing textbooks which ought to be sustained to a significant extent. There's significant investment in TV shows, films and social media advice aimed at learners. Many teachers make significant personal investment in science clubs, good teaching practice and innovative teaching, and their commitment to education should be afforded the recognition it deserves.

"Are we going to spend our energy on fighting each other on this or agreeing on workable interventions?"

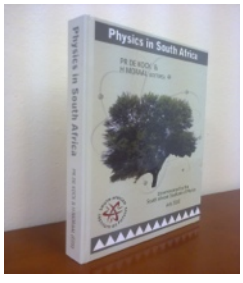
Companies add laboratory endowments, expos, Science Centres, Exploratoria, and indeed open days through their social responsibility initiatives. Government is active in policy, governance and in major school projects. The University of Johannesburg Soweto Science Centre coordinates a learner enrichment programme as well as the Teacher Development Project in partnership with SAIP and the Institute of Physics (UK). Commensurate with the need to consolidate teacher professional development within a broader South African context, 600 teachers from Gauteng are set to be trained at the Soweto Campus of the University of Johannesburg during July 2014. Textbook provision, curriculum development, and teacher training are acknowledged as key areas of concern where profound, evidence-based development is needed on an unprecedented scale. SAIP is calling for support from government departments for teachers to be trained at universities, in-service or relevant Further Education and Training institutions in order to ensure appropriate physics mastery.

South Africa's second Nobel Prize in medicine was for the maths behind the Computed Tomography X-ray scan so widely used in hospitals to diagnose tumours, trauma and diseases. South Africa's next Nobel Prize winner in physics may well be in school as we speak. It's time for authentic engagement, get some facts straight, fight ignorance, and fix the problems at hand.

Purchase the book *Physics in South Africa*

Order from SAIP Office.

The book is currently available from the SAIP Office in Pretoria in hard copy and currently priced as



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Launch of the first Meerkat Antenna

by Dr Igle Gledhill, CSIR, on the 27th March from the Northern Cape.

On March 27th, 2014 history was made when Minister Derek Hanekom cut the sky-blue ribbon across the pedestal door of the first Meerkat antenna at the SKA site in the Northern Cape. He hosted Ministers, Deputy Ministers and representatives from SKA partner countries Botswana, Kenya, Madagascar, Mauritius, Mozambique and Zambia at the launch of this SKA Precursor Facility.

"For Meerkat, this is one antenna done and 63 to go," he said. The project will contribute to the common benefit of the scientific community and ultimately of humanity. In speaking of SKA as the largest and most sensitive telescope ever built, with a purpose "almost ridiculously outrageous and ambitious", he referred to the 'premeditated adaptability' built into such a large experiment, whose life time will necessarily include the invention of new technologies.

Dr Bernie Fanaroff , SKA SA Project Director, Prof George Nicholson

The SKA project is deliberately positioned to benefit the Northern Cape region with human capital development and techno-

logy. In the words of one Bed-and-Breakfast manager, "It's turned Carnarvon form a one-horse town in to a two-horse town."

Deputy Minister Michael Masutha pointed out that rural communities are much more appreciative of this type of initiative than one might think: "these people know how much hard work it takes if you don't have a good quality education", he said. "Very poor people will sacrifice the little they have to make sure that their children have a chance".

"The issue of the knowledge economy as an aim of the future is very real – we have seen how the ICT boom has separated those countries that took full advantage of it from those that did not."

Prof Justin Jonas continued working on cabling at intervals in the proceedings

The community of astronomers, physicists, astrophysicists and space scientists have worked hard over the last decade and more to reach this milestone. The 27th of March 2014 is not only making history, but also making the future.

From the left: Dr Phil Mjara, Dr Igle Gledhill, Prof Phil Diamond, Director-General of the SKA Organisation

2014 WiPiSA Call for Proposals

by Dr Malebo Tibane, SAIP Secretary

There is a growing global concern over the declining number of students at higher education institutions enrolling for, and graduating in, physics. South Africa, like many other countries, experiences under-representation of women in physics in all institutions, including academia, research and development, government institutions and industry. In November 2005 Women in Physics in South Africa (WiPiSA) was launched, with funding from the Department of Science and Technology (DST) and under the auspices of the South African Institute of Physics. WiPiSA aims to address the following areas of concern:

· Attracting girls into physics, including changes in teaching and curricula

· Launching a successful physics career, including mentoring and evaluation

· Getting women into higher positions in institutional and leadership structures

· Breaking stereotypes

· Balancing family and career

· Jobs

· Funding, and eligibility for funding

· Improving the institutional structure and climate for WIP.

In 2014 WiPiSA has again received a grant from DST to address the issues listed above. We are therefore calling for proposals for projects of up to R30 000 to be submitted by 23 June 2014.

Proposals should include: (i) The aim of the project, clearly indicating which WiPiSA aim(s) it will further. (ii) Who will be involved in the project, and what knowledge and experience they have that are relevant to the project (attach abbreviated CVs of team members). (iii) Who the intended beneficiaries are of the project (the target group). (iv) What the intended outcomes are of the project. (v) How the success of the project will be evaluated. (vi) A project plan, including what activities will take place where and when. (vii) A detailed budget.

Funds will not be transferred into the accounts of individuals. Arrangements must be made with a public or private organisation, such as a university, national facility or NGO, to administer and account for any funds awarded for successful proposals. In assessing the proposals, the following criteria will be considered:

- Aims: the match between the aims of WiPiSA and the aims and intended outcomes of the project.
- Project team: their knowledge, skills and experience in relation to the proposed project.
- Proposed activities: how appropriate and feasible they are for achieving the stated aims
- Budget: whether it offers value for money, is realistic, and includes an adequate breakdown of all relevant expenses
- Evaluation: whether appropriate information will be collected and made available about the extent to which the project was successful.

Deadline: This is an open call for proposals, subject to availability of funds.

Projects must be completed by 31 January 2015 and completed report to be submitted by 28 February 2015.

Proposals should be sent by email to Malebo Tibane, tibanmm@unisa.ac.za

WiPiSA Departmental Lunches Funding Opportunity

by Dr Malebo Tibane, SAIP Secretary

Two of the main objectives of WiPiSA are

- to encourage and stimulate an interest in girls and women to study physics
- to support girls and women to work in physics-related careers and assist in removing/overcoming obstacles and barriers for girls and women in their studies and at workplace.

To meet this objectives we initiated an idea to have departmental lunches across universities within South Africa. The lunch activity is expected to bring women in physics together; academics, those in leadership roles and students (both undergraduates and postgraduates) to enjoy a meal together while encouraging and stimulating interests in others to study physics, networking and talking about some challenges they are facing as women in physics.

WiPiSA will provide a funding of R3000-00 only for your institution to organize the lunch. We therefore request you to help us accomplish this goal, or forward the name and contact information of the representative from your department to facilitate this activity. We would appreciate if the lunch event can be held before the end of November 2014 as this will help us to compile a report. WIPiSA expects you to send us:

- A short report about the event (venue, number of attendees, activities, etc).
- The outcomes of the event (students were motivated, links established, etc).
- Few event pictures.

Please do not hesitate to contact me at *tibanmm@unisa.ac.za* for further enquiries.

Join SAIP Membership

By Brian Masara (SAIP office, Pretoria)

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.

What members say about SAIP membership

Dr Igle Gledhill - It's useful to have a professional home that is not an employer or an alma mater. I came back from four years in the USA and switched fields at the same time. Funnily enough, SAIP is home – the banquet is a hoot, the conferences keep me up to date, the Institute is serious about science in South Africa and gets things done, and my colleagues keep me on my toes.

Dr Daniel Moeketsi - SAIP provide a platform to showcase physics research progress and direction in the country and expose students to many career opportunities both in public and private sector. I encourage postgraduate students to subscribe for SAIP membership and actively participate in the organisation's annual activities.

Membership benefits

I. 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.

II. 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.

III. Save Money - You'll receive discounted rates for SIAP conferences, and have the benefit of paying affiliate membership fees for IOP membership.

IV. Employment opportunity information - Job advertisements will be displayed on our new website and mailed to members from time to time.

V. Access to current information on sources of funding grants and scholarships - Exclusive service provided to our members via a direct email system.

VI. Scientific meetings - The annual conferences and workshops provide learning opportunities for different specialisation areas and varying degrees of experience.

VII. Especially for the global physics community - You'll have the opportunity to be partake in events organised by the SAIP for the Physics community in South Africa as well as Africa: developmental workshops, schools and conferences.

VIII. Additional resources - Your membership privileges also include information and guidance when applying for and acquiring visas to study, participate in scientific meeting and research opportunities in South Africa and abroad. There is also an exclusive member-only area on our website.

IX. Career guidance and resources - Career assistance is provided to all members to find their career path in industry or academia.

X. 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.

XI. 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

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 here on confidentiality and great benefits of signing up and updating your details

To register click here .For enquiries contact SAIP Office at info@saip.org.za

On the inside track

This article first appeared in the IOP magazine **Physics World** *in September 2013 (Issue 9). With kind permission to republish given by its editor, Matin Durrani.*

Industrial scientist Brent Neal explains what physics graduates and PhD students can do to make themselves stand out to recruiters

One of the things I enjoy most about my job as an industrial scientist is recruiting new talent. It is a great opportunity for me to look at the work of the best and brightest students and, in some cases, to dig into their work as I interview them. Sadly, a lot of academic advisers and supervisors seem to view industrial research as a fallback option for students who can't get faculty positions. This is an unfortunate attitude that results in many students having little idea of what it takes to land an industrial job. I have therefore compiled a few tips for people who are wondering about careers in industrial research and what it takes to land a good position outside of academia.

Building an industry CV

Your CV or resumé is a record of your academic career and is the first thing about you that a hiring manager will consider. What we look for when we read a CV are your accomplishments, so tailor it accordingly. Although you should spend some time on your cover letter, don't worry about writing an objective statement: your hiring manager already knows that you want a job. Instead, concentrate on highlighting occasions when you showed leadership and the things you did to make your project successful, using action words and an active voice.

If you are applying for positions that require a bachelor or master's degree, we want to see evidence of productive contribution, such as publications (particularly for a master's student), poster awards, or demonstrated technical skills. For doctoral-level scientists, we also want evidence of your technical leadership, especially your publications, which should be the centrepiece of your CV. Be exhaustive and upfront in listing them and be prepared to send any potential interviewer a copy of one of your papers to discuss. I look primarily at the quality of the publications and where your name shows up in the author list. A bullet list of accomplishments will then tell me something about the work you did to get those publications. You should have made substantial contributions to the direction of your research, be able to identify key pieces of your work and convince me that they wouldn't have happened without you. Make sure that every experiment or theoretical project you do has your mark on it.

Like other hiring managers, I also look for things that set you apart. For undergraduates, that might mean taking the opportunity to work with a research group, even if you have to volunteer, and earning your independence by being a productive contributor. Having a publication record as an undergraduate is a signal to most hiring managers that you may be a high performer. And it does not have to limit you to a particular field: it is fine to change direction after your undergraduate degree, so don't feel that your research experience locks you in to one particular area.

> A great way to convince me that you have the ability to be a technical leader is to tell me about your top-secret hush-hush project

If you are a PhD student, things that set you apart might involve taking responsibility for training or supervising a junior postgraduate student, undergraduate or perhaps a small team. You should also consider taking on extra research tasks such as assisting your adviser with grant writing or doing preliminary work for a new grant. Writing a review article or a book chapter clearly demonstrates technical mastery. Your adviser can help you find these kinds of opportunities.

Another great way to convince me that you have the ability to be a technical leader is to tell me about your top-secret hush-hush project. You know – the one that your adviser absolutely forbade you to work on, but you did anyway, and that has just now been published in Macromolecular Rapid Communications (with your boss' name in the prestige position, of course). The ability to keep your boss happy while doing the research that you think is important and that will shape your field is a skill that good industrial scientists should cultivate. When I'm looking to hire someone, I look carefully for that kind of initiative.

The other piece of CV advice that I give undergraduate students can be a little controversial. In talking through the material for this article with some of my peers from other firms, I have found that many major companies have key universities from which they recruit, and they do not always cast their nets much further. That may not seem fair, but you don't have to play guessing games about it, since these "key universities" are often in the top 10 for a particular field. So if you are looking for places to do a PhD, I advise you to choose good universities, good programmes and good professors. You can also look at where graduates of particular programmes end up, since the better programmes will be able to tell you where their students have found jobs. If a department places four to five students at a company every year, then you can assume that the company actively recruits there. If you're already writing your dissertation, though, all hope is not lost. Start looking for postdoctoral positions at a select group of universities and with top professors. A productive postdoctoral position can jazz up a CV.

Cultivating and using networks

Building a robust network of colleagues can be invaluable in your job search. Set up a LinkedIn profile if you don't have one, then populate it. When you go to meetings and conferences, talk to academics with whom you might want to take a PhD or postdoctoral position. Talk to industrial researchers who might be there. I guarantee that all of us who are at a conference are looking at the students and sizing them up as potential new hires. Ask us questions about what we do and what we think you should do to get hired down the road.

If your adviser or supervisor has been around for a while, check in with some former group members who have gone into industry. They will often give you a good inside scoop on when positions will be available. I like to go back to the same groups for recruiting, because the senior members will know what I'm looking for in a new hire and I can get an honest opinion about any candidate from their group.

Internships and industrially sponsored research projects are great opportunities not only to gain useful experience and skills (plus a high-impact bullet-point on your CV), but also to network with your contacts at the sponsoring company. Be upfront with them about your interest in industrial research and ask for advice and mentoring on some of the skills that will make you irresistible to their hiring managers.

There are many good reasons to make a career in industry your first choice. But both academia and industry have their pros and cons, so as you start thinking about career paths as an undergraduate or junior postgraduate student, make sure you find people to talk to who will give you good perspectives on the different choices.

Brent Neal has degrees in materials science and physics and has worked in a variety of fields, including computational physics, software development and polymer science. He currently leads the central analytical facility at Milliken & Company *in South Carolina, US, e-mail brentn@ brentneal.me*

Obituary Dr L.R. Botha

by A.M.Smit, et. al., National Laser Centre CSIR, Pretoria

On the 17th of January 2014 Dr L.R. Botha passed away at the age of 52 years, after contracting the extremely rare cancer of the heart. Even though he survived open heart surgery in August 2013 the cancer had unfortunately spread to the lungs. He was the Competency Area Manager at the CSIR National Laser Centre (NLC), which he held since 2004.

Lourens Rasmus Botha was born on the 15th of March 1961 in the town of Morgenzon, the only child of Lourens Rasmus Botha, the Principle of Hoër Landbouskool Hoëveld, and Yvonne Botha, the Music teacher, where he later matriculated in 1978. He completed his BSc in 1981, BSc Hons (Physics) in 1982, MSc (Physics) in 1984 all at the University of Pretoria. After completing his two year National Service in the SA Army where he became an Officer, he joined the Atomic Energy Corporation of South Africa (AEC, currently NECSA). In 1992 he obtained his PhD (Physics) at the University of Natal, Durban: "High repetition rate continuously tuneable laser system investigation". At the AEC he worked on the Molecular Laser Isotope Separation programme as Senior Scientist and group leader of modelling until 1998.

He then became one of the founding members of a high technology start-up company called Scientific Development and Integration (SDI), where he was the Director responsible for the laser side of the business. Under his leadership, the laser group became a thriving business that exported to many prominent companies in the USA, Europe and China.

His passion for the academia and state of the art in laser technology made him sell his share in SDI in 2004 to an international investor. He joined the CSIR NLC as Competency Area Manager and led the following groups: Laser Systems, Mathematical Optics, Biophotonics and Femtosecond Science and Spectroscopy.

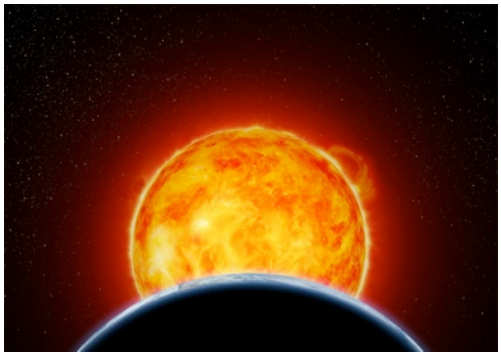
In addition to his managerial responsibilities he also ran his own research program in the field of ultra-fast phenomena. During the last three years, he supervised four MSc and one PhD students. He was also an extraordinary staff member at the Physics Department at the University of Stellenbosch and published more than 35 papers in peer reviewed journals or in peer reviewed conference proceedings. His last main research activities included ultra-short pulse science and particularly coherent control of complex systems using time domain beam shaping. He also had an interest in mid-IR solid state and optically pumped molecular lasers.

Most people were unaware that Lourens was impaired. He lost sight in an eye when he was 9/10 years old in an airgun shooting accident. Notwithstanding, he excelled at sport and played rugby for his school, TUKS and the army. He was a man's man and loved the outdoors and hunting and still was a great devoted family man. He is deeply mourned by his beloved widow Erna and his daughter Lara (13) and all his many friends and colleagues.

The memories I have of Lourens can be best described by:

You see things; and you say "Why?" But I dream things that never were; and I say "Why not?" –
Sir George Bernhard Shaw

It was an absolute pleasure to have this Man as a Friend!



Articles

The Impact of Space Weather

By Catherine Webster, Communications Officer
SANSA Space Science

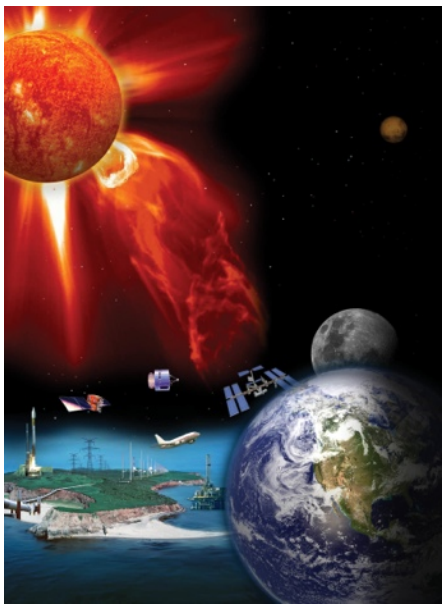
Introduction

Since the early nineties the Sun and its daily activity has had a significant impact on humanity and in particular on modern technology. Space weather as a concept and as a new research area was born. Today it is a hot topic around the world and has become increasingly important to society, industry and national security.

The impact of space weather socially and economically requires that we are aware of and ideally able to preempt the consequences of space weather events, by means of efficient warning and prediction systems. An extreme space weather event or solar superstorm is a potentially high-impact, low-probability natural hazard. Due to a growing awareness of the potential consequences of extreme space weather, governments in numerous countries now consider this as an element of national risk assessment.

Superstorms may have detrimental effects to the power grid, satellites, avionics, and aircraft over polar regions, High Frequency (HF) radio communication, mobile telephones and GPS systems, to name a few. Solar superstorms have consequently been identified as a risk to the world economy and society.

Caption: Space weather may impact technological systems such as satellites, power grids, avionics and radio communication.



Protecting Technology on Earth and in Space

SA Space Agency keeping an eye on Space Weather

The South African National Space Agency (SANSA) is host to the only Space Weather Regional Warning Centre in Africa and operates as a part of the International Space Environment Service (ISES). SANSA Space Weather Centre provides an important service to the nation by monitoring the Sun and its activity, providing space weather forecasts, warnings, alerts, and environmental data on space weather conditions to governments and private industries in Africa.

SANSA collaborates with various institutions nationally and internationally on space weather research including the impacts of space weather on radio communication systems, global positioning systems, power systems and on satellite technologies. SANSA is also developing algorithms for the estimation of the time of arrival and intensity of space weather storms based on observations from satellites and ground based instruments.

Several SANSA research activities are focussed on improved modelling, predicting and forecasting of space weather. There are many areas of research that are contributing to an improved understanding of space weather and its effects at South African latitudes.

What is Space Weather?

Space weather refers to a collection of physical processes, beginning at the Sun and ultimately affecting technology on Earth and in space. The Sun emits energy by means of electromagnetic radiation, coronal mass ejections (CMEs) which release high-energy charged particles, and plasma streams.

The charged particles from the Sun travel outwards in the solar wind, carrying parts of the Sun's magnetic field. The electromagnetic radiation travels at the speed of light and takes about 8 minutes to move from the Sun to Earth, whereas the charged particles travel slower, taking a few hours to several days to complete the same journey. The radiation and particles interact with the Earth's magnetic field and outer atmosphere in complex ways which may cause disturbances to technological systems in space and on Earth

What are the Effects of Space Weather?

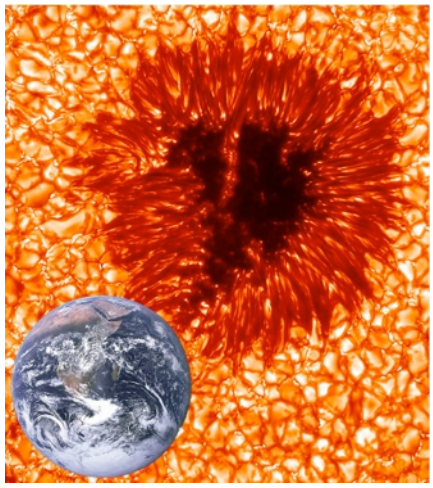
Space weather may have detrimental effects on space and ground based technology. Magnetic disturbances induce electric currents in long conductors such as power lines and pipelines. This may cause power outages or excessive pipeline corrosion. Magnetic disturbances directly affect operations that use the magnetic field, such as magnetic surveys, directional drilling and the use of compasses. Radio waves, which are used for satellite communication and GPS navigation, are affected by the increased ionisation of the atmosphere, leading to disruption of communication and/or navigation systems. Satellites may suffer damage to electronics due to radiation.

To gain a deeper understanding of space weather let us consider various processes of the Sun

The Sun & it's Solar Cycle

Our local star, the Sun, is a huge ball of boiling gas with a very strong magnetic field that rotates with a differential rotation on its axis with different velocities at the poles. This differential rotation twists the magnetic field and causes a variety of solar features. In order to see the different structures, the Sun is observed in a variety of wavelengths, ranging from hard X-rays to radio.

The magnitude of the magnetic flux that rises to the surface of the Sun, follows 11-year cycles of activity known as the solar cycle or sunspot cycle. During this cycle the Sun reaches periods of maximum and minimum solar activity. Solar minimum refers to a period when the number of sunspots is small, resulting in less solar activity. Solar maximum is the period when the number of sunspots is high, resulting in more frequent solar activity.



Caption: The Royal Swedish Academy of Sciences, V.M.J. Henriques (sunspot), NASA Apollo 17 (Earth) A colorized photo of a sunspot taken in May 2010, with Earth shown to scale. A small sized sunspot is about the size of Earth.

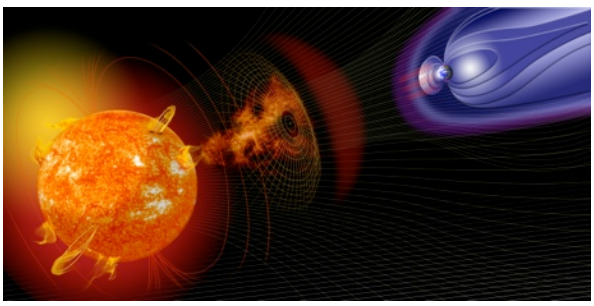
Sunspots and Solar Active Regions

Sunspots are dark features that appear on the surface of the Sun. They vary in size, shape and lifetime. Sunspots appear in areas where the magnetic field is very strong. They appear to be darker than the gas surrounding them, because they are several thousand degrees cooler.

However, when sunspots are observed by means of ultraviolet or X-ray filters, there appears to be high emission activity in the corona. That emission is produced by the plasma that travels on the powerful magnetic fields emerging from the sunspots. We refer to the whole view as solar active regions. Active regions may produce coronal mass ejections which may result in solar superstorms.

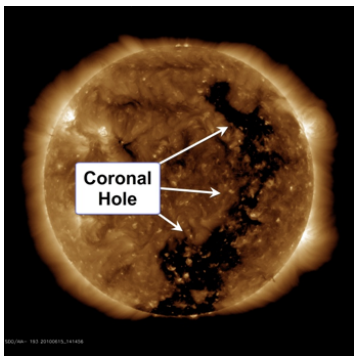
Solar Wind

The solar wind is a stream of charged particles constantly flowing from the upper atmosphere of the Sun. It consists mostly of electrons and protons and varies in temperature and speed over time.



Caption: The loops on the sun are magnetic field lines that terminate on sunpots, which are active areas on the solar surface. When these magnetic loops flare out into interplanetary space, they emit radio waves which reach the Earth 8 minutes after the flare. The magnetic flares also carry with them a cloud of high energy particles known as the solar wind, which travel at supersonic speeds of up to 800 km/s. If the solar wind is Earth directed, it reaches the Earth within a day or two where it causes disturbances in the upper atmosphere and on the Earth's magnetic field.

Coronal Holes



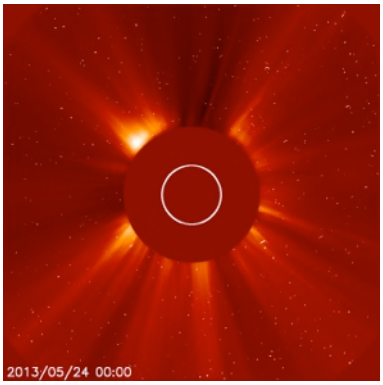
These are large holes in the Sun's corona that are caused by the magnetic field. They are less dense and cooler than surrounding areas. High-speed solar wind streams flow from coronal holes into space at speeds of up to 800 km per second. If conditions are right and these streams reach the Earth, geomagnetic storms may occur.

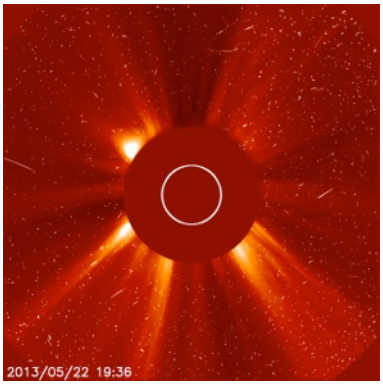
Caption: High-speed solar wind streams from coronal holes may cause geomagnetic storms on Earth.

Main Solar Events

Solar Flares

A solar flare is an eruption of matter on the surface of the Sun which is accompanied by an emission of electromagnetic energy in the form of gamma rays and X-rays. The biggest flares can be hundreds of times the size of the Earth. A flare's intensity may be measured in X-ray flux and is grouped in 5 classes A, B, C, M and X. Each class of flare is ten times more powerful than the previous, with A-class flares being the weakest, and X-class flares being the most energetic.





The electromagnetic energy of solar flares takes approximately 8 minutes to arrive on Earth and their effects may last for a few hours. Effects include interference in radio and satellite communication, HF radio blackout and GPS errors.

Caption: Solar energetic particles (SEPs) can interfere with satellite electronics. These images show the different between quiet (left) and noisy (right) SEP conditions.

Solar Energetic Particles

Solar Energetic Particles (SEPs) are high-energy charged particles originating from energised solar flare sites or by shock waves associated with CMEs. SEPs consist of protons, electrons and heavy ions and their energy ranges from a few tens of keV to GeV. They are of particular interest and importance as they can endanger life and technological systems in outer space.

SEPs travel between 15 minutes and a few hours on their journey to Earth and their effects may last for a few days. Effects include satellite anomalies, radiation risk to high latitude flights and astronauts, HF radio blackouts and glitches to avionics.

Coronal Mass Ejections

A Coronal Mass Ejection is a large cloud of charged particles that is ejected from the surface of the Sun when stored energy is suddenly released. A CME may disturb the Earth's magnetic field. CMEs take approximately 1-4 days to arrive on Earth and their effects may last for a few days. Effects include geomagnetic storms, HF radio blackouts, disturbances to power grids and long distance pipelines, GPS errors and satellite anomalies.

Caption: CMEs travel at supersonic speeds of up to 2000 km per second. At that speed you would get from Johannesburg to Cape Town in less than one second.

Solar events thus influence technology in space and on Earth. But what happens if they create a space weather storm?

Space Weather Storms

Geomagnetic Storms

A geomagnetic storm is a temporary disturbance of the Earth's magnetic field, caused by sudden strong variations in the speed, density and magnetic properties of the solar wind. The resulting magnetic field variations

generate electric currents in long conductors such as power lines and pipelines. The effects of geomagnetic storms range from mild (interference with aeromagnetic surveys) to extreme (electric power grids may experience blackouts).

The strength of the geomagnetic storm depends on the size of the coronal mass ejection and the magnetic field associated with it.

When that field points southward, its interaction with the Earth's magnetic field is stronger, increasing its influence on the Earth's magnetic field. How soon that storm impacts the Earth, is determined by the speed of the CME. These parameters may all be measured by satellite before the CME reaches the Earth.

Geomagnetic storms are characterised by a K-level index that ranges from 0-9. Storms with little effects range from K=0-3, mid-level storms measure between K=4-7, and heavy storms measure between K =7-9.

Ionospheric Storms

Solar activity such as solar flares and coronal mass ejections may lead to turbulence in the ionosphere known as ionospheric storms. These tend to generate large disturbances in ionospheric density distribution, total electron content, and the ionospheric current system. Ionospheric storms may impact satellite communication and the flow of electrical energy.

Mitigating the impact

The monitoring and forecasting of space weather allows preventive and mitigating measures to be taken. Satellites can be switched to a safe mode from which they are more likely to recover, space walks by astronauts can be postponed, satellite launches and magnetic surveys can be rescheduled, radio communication and cable television disturbances can be anticipated and not attributed to faulty technology, and power systems can be shut down to reduce the impact of a geomagnetic storm.

Developing knowledge of the space environment allows for a better understanding of its impacts. Research is currently underway on investigating cost effective technologies to mitigate the potential impact. Knowledge and understanding is the first point of protection and effective mitigation of impacts of all space weather effects.

Image Source: NASA

Wrinkles in the early universe?

Dr Moumita Aich, UKZN, Durban

Introduction: Era of precision cosmology

The hot Big Bang model is the most widely accepted explanation of the origin of the universe. The detection of the CMB (cosmic microwave background) in 1965 by Arno Penzias and Robert Wilson is the most compelling evidence of the Big Bang. The extreme uniformity of the CMB radiation (1 part in 10,000) all over the sky is a plausible reason to interpret it as the thermal remnant of the Big Bang. This relic radiation has a thermal blackbody spectrum of 2.725K and is truly a snapshot of the very early universe. The COBE (COsmic Background Explorer) satellite first detected fluctuations in the CMB, of the order of few micro-K, in 1992, which would be key to understand the evolution of the universe. However, the extreme *flatness* of the universe, observed CMB temperature equilibrium between casually disconnected *horizons* of the universe and absence of magnetic *monopoles* formed at Big Bang are a few of the fundamental physical shortcomings which plague this model. An epoch of accelerated expansion in the early universe, referred to as *inflation*, is currently the most accepted theory to complement the hot Big Bang Model. Inflation overcomes the fundamental problems of the hot Big Bang model and results in tiny perturbations in the nearly uniform energy density of the early universe, which gets imprinted naturally in the CMB temperature fluctuations. The inflationary scenario was originally proposed and coined by Alan Guth in 1981 [1a]; independent work by Alexei

Starobinsky [1b] and Katsuhiko Sato [1c] also pointed to an initial exponentially expanding phase in the early universe.
The CMB anisotropies arise mainly due to density fluctuations in the primordial soup of particles. In addition, inflationary theory postulates the presence of a stochastic background of primordial gravitational waves, seeded during the inflationary epoch, which would also leave its imprint in the CMB. Linear polarization at the level of a few micro-K is produced by Thomson scattering of the CMB photons off electrons. This polarization field is decomposed into gradient part (scalar/E-modes) and curl part (tensor/B-modes). Although the E-modes arise naturally from Thomson scattering in inhomogeneous plasma, primordial B-modes cannot be produced from density fluctuations; they are a signal at *degree angular scales*, originating during inflation and are determined by the density of primordial gravitational waves. Weak gravitational lensing due to intermediate large-scale structures in the universe, affects the CMB temperature and polarization signals. Weak lensing causes a transfer of E-mode polarization into B-mode signals, which peaks at *small angular scales*. It is important to note that these *lensed B-mode* signatures are physically and observationally distinct from the *inflationary B-modes*. The *degree-scale B-mode* signal is unique and compelling evidence for the existence of primordial gravitational waves seeded during the inflationary regime, and furthermore allows a direct measurement of the energy scale of inflation.

The era of precision cosmology involves accurate measurement of the CMB temperature and polarization by various experiments. A non-exhaustive list of some of the notable ground-based experiments includes DASI (Degree Angular Scale Interferometer), POLARBEAR, ACT (Atacama Cosmology Telescope), SPT (South Pole Telescope), ABS (Atacama B-mode Search), QUIET (QU Imaging ExperimenT), BICEP (Background Imaging of Cosmic Extragalactic Polarization) and KECK Array. Few of the balloon-based experiments are ACBAR (Arcminute Cosmology Bolometer Array Receiver), MAXIMA (Millimeter Anisotropy eXperiment Imaging Array), BOOMERanG (Balloon Observations Of Millimetric Extragalactic Radiation ANd Geophysics), EBEX (E and B Experiment) and Spider. Space missions WMAP (Wilkinson Microwave Anisotropy Probe) and the Planck satellite offer vast improvement in resolution compared to the former two classes of experiments. However, the ground and balloon based experiments have much smaller instrumental noise power spectra and are extremely cost-effective. Traditionally, starting with the discovery of the CMB using the Holmdel Horn Antenna at Bell Labs, ground and balloon based experiments have made game changing first discoveries in this field. These include the first estimation of a flat universe using CMB data by Boomerang/MAXIMA, first detection of E-mode polarization by DASI, small scale lensing B-modes by SPTpol/POLARBEAR and the very recent claims of degree angular scale inflationary B-mode signature by BICEP2 and Keck Array.

Exquisitely accurate reconstruction of the temperature anisotropy angular power spectrum and the E-mode polarization spectrum exists due to these various experiments. SPTpol, dedicated to observation of CMB polarization, detected the *small-scale, lensed B-mode* spectra [2] which has a disparate signature to that of the *degree-scale inflationary B-modes*. The challenge lies in detecting this much weaker B-mode polarization at *large scales*, which could be a confirmative proof of the inflationary scenario.

Inflationary models

Inflation continues to remain the most promising paradigm for describing the origin of the perturbations in the early universe, which are predicted to be Gaussian in nature. It has been performing remarkably well against the observational data, and the challenge for the other competing scenarios is to match the simplicity and efficiency of inflation.

One of the plausible scenarios for driving inflation is the *inflaton field*, a scalar field generated from early universe particle field models. This inflaton field undergoes a regime of slow-roll [3] where the potential energy, which is sufficiently flat, dominates the kinetic energy. A key requirement is that inflation must continue long enough to produce the present observable universe and is typically satisfied with an expansion by a factor of 10^{30}. During the inflationary regime, the temperature of the universe drops by five orders of magnitude due to super-cooled expansion and the inflaton energy dominates. The process of reheating causes the decay of high potential energy of the inflaton field into standard model particles and electromagnetic radiation [4a]. Without reheating, inflation would leave behind a universe devoid of matter as the temperature required for standard nucleosynthesis would not be attainable. The mechanism of reheating occurs via

parametric resonance and results in quantum mechanical production of matter particles in a classical background inflaton field [4b,4c]. The initial phase of energy transfer dubbed as preheating, results in extrememly efficiently transfer of energy from the coherant oscillations of the inflaton field. The decay products interact, redshift and soon get thermalized while dominating the energy density of the universe.

Many models of inflation lead to an epoch of slow roll as formulated by Andrei Linde. This leads to a featureless, nearly scale-invariant, power law primordial scalar spectrum, also confirmed by different CMB observational data. The amplitude of the perturbations and the spectral tilt n_s characterizes this simplest scenario. The CMB data allows a precise estimation of these inflationary parameters along with other cosmological parameters, like the energy densities of various components of the universe (baryons, dark matter and dark energy), and the reionization optical depth. The energy scale of inflation is determined by the *tensor-to-scalar ratio r*, the ratio of the gravitational waves background and the density fluctuations power spectra.

Occassionally, effects are observed that appear to contradict the simplest models of inflation. Comparison with recent CMB observations brings forth certain significant outliers in the CMB temperature angular power spectrum that motivates a study beyond the standard model of inflation. Certain discrepancies seen in the large angular scales are attributed to either modification to the power law inflationary power spectrum, departure from Gaussian initial conditions, foreground contamination or seeds of unexplored early universe physics. On the theoretical front, fine-tuning of initial conditions, the balance of the inflaton field in the standard model of particle physics, graceful exit of inflation are a few of the open questions. Since its inception, inflationary theory has undergone rapid extension in the number of plausible models to accommodate some of the above physical acquisitions. These models lead to different predictions for the perturbations, which gets imprinted in the CMB anisotropies. High-accuracy measurements are capable of distinguishing between these signatures thus narrowing the wide range of viable inflationary models.

Andrei Linde's *chaotic* inflation model is a typical example of *large-field* models, where the inflation begins in a chaotic, high-energy state and then undergoes a slow-roll phase, leading to a reasonable tensor spectrum indicated by large values of r. From the perspective of effective field theory, these models are not considered to be very well motivated [5]. The *small field* inflationary models offer an important alternative to the large field models, better motivated from the high-energy physics perspective. Inflation occurs at a much lower energy scale and is terminated naturally also leading to smaller values of r, typically $r<0.1$.

Some theories modify the gravitational sector instead of introducing an explicit scalar field. A few of the popular models of inflation are the *Starobinsky model*, *natural* inflation, *hybrid* or *multi-field* models and *eternal* inflation, to name a few. Current CMB data helps to distinguish these various classes of inflationary models by exploring the cosmological parameter space.

Cosmology at the South Pole

The CMB E-mode polarization signal is about an order of magnitude smaller than the CMB temperature anisotropies. The peak amplitude of the primordial B-mode signal would be still an order lower even for a large value of $r\sim0.2$. While the theoretical case for observing CMB polarization is strong, it is a difficult experimental task to observe these signals. Given that the amplitude of the polarization is so small, the question of Galactic foregrounds is even more important than for the temperature anisotropy. These astrophysical foregrounds are free-free (bremsstrahlung), synchrotron, dust and point source emissions. Detection of the weaker B-mode polarization thus has been extremely challenging.

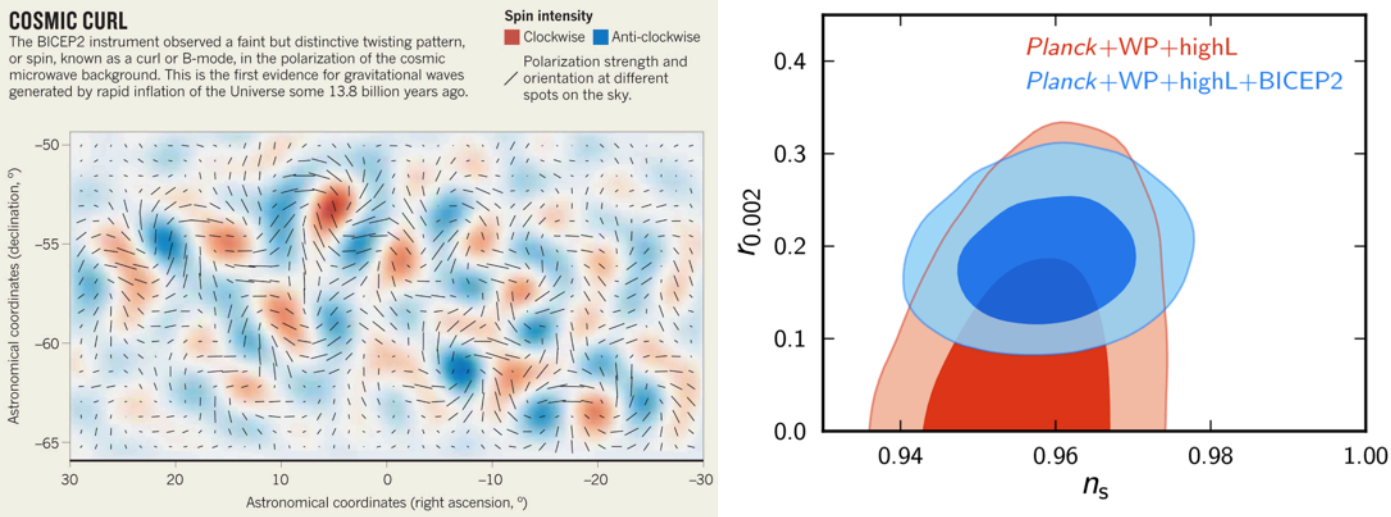
Low atmospheric noise at the South Pole makes it ideal for CMB experiments. The location has optimum observing conditions due to low humidity and temperature, and low pressure due to the high altitude and thin atmosphere. Moreover this location has access to an unusually clean patch of sky called the 'Southern Hole', which has an exceptionally low level of foreground contamination from Galactic synchrotron radiation and dust. It is a perfect window to observe these weak signals allowing for optimal viewing into the very early universe. The sky never sets at the Poles, which gives an added advantage in the sensitivity charts. Continual scanning of the same patch of sky, highly increases the signal-to-noise ratio.

BICEP and the Keck Array are a series of CMB polarization experiments at the South Pole. These were dedicated to the discovery of the unique primordial B-mode polarization signature of the CMB. BICEP1 (B1) had an array of 98 detectors and observed at 100 and 150 GHZ. BICEP2 (B2) was the second- generation instrument observing from 2010 to 2012 and the focal plane featured new transition edge sensor (TES) bolometer technology and increased packing density (512 TESs at 150 GHz). Each generation represents a large increase in sensitivity to B-mode polarization. The first three of five Keck Array telescopes began observing in the beginning of 2011, each with 512 detectors. The final two Keck Array receivers were deployed during the summer of 2012. BICEP3, with a total of 2,560 detectors, will begin observing in 2015.

Recent CMB observations

On 21 March, 2013, Planck, a space based experiment launched by the European Space Agency, released the mission's data and all-sky CMB temperature maps which are to date the most detailed temperature maps at the level of arc-minute resolution. Cosmological parameter estimation using this data in the standard ΛCDM scenario, provided an upper limit to the tensor-to-scalar ratio at r<0.11 at 95% confidence limit. This projected low value of r projected a strong preference for small field models as the preferred class of inflationary models compared to large field models like chaotic inflation [6]. However more stringent constraints will be achieved using the Planck CMB polarization data, expected to be public in October 2014.

On 17 March 2014, the BICEP2 team detected a signal in the large-scale CMB B-mode power spectra, the primordial gravity wave template serving as a conclusive fit to the observed excess. The team announced the discovery of the elusive large scale B-modes that could be interpreted as evidence of primordial gravity waves during the inflationary epoch. The team sets a constraint on the tensor-to-scalar ratio r=0.2, disfavoring the null hypothesis r=0 at a significance of 7σ (5.9σ after foreground subtraction). Using these results, the energy scale of inflation as predicted by the simplest chaotic models (10^{15}–10^{16} GeV) seems feasible with a high tensor-to-scalar ratio of r~0.2 [7].



Left: Distinctive pattern of the B-modes, 45° to the x-y axes, with amplitude of 0.3μK. *Right:* The r-n_s degenracy plane, where the dark and light colored contours represent the 1σ and 3σ confidence limits. WP indicate data from WMAP E-polarization measurements, while highL indicates data from small angular scale experiments like ACT and SPT.

Cosmologists cannot lay enough stress emphasizing the tremendous significance and importance of this result. If accurate, this signal would truly be the first detection of degree-scale B-modes which are a signature of primordial gravitational waves originated during the inflationary epoch. But extraordinary claims require extraordinary evidence. The largest source of uncertainty is foreground confusion as stated in the B2 paper [7]. The cross-correlated analysis of the B1 result (100 GHz) x the B2 result (150 GHz) result gives only 2σ confidence that the B-mode signal is CMB rather than a single-component foreground. The B2 x B2 result is very intriguing and isn't obviously incorrect at this point in time. Independent confirmation from other experi-

ments with differing systematics, looking at other parts of the sky and at other frequencies is what is required in this field now.

Once the initial excitement of these intriguing results sank in the scientific community, many researchers started questioning the interpretations of this extremely weak detection. The most serious criticism rose by Flauger et al. [8], claiming the BICEP2 team may have underestimated the contribution of galactic dust in their analysis. This would lower the strength of the signal attributed to primordial gravitational waves, making it less statistically significant. A more detailed dust map released on 6 May 2014 by the Planck collaboration, did not cover sky patches at high galactic latitudes and excluded the region examined by BICEP2 [6] due to low signal–to-noise ratio and high uncertainties. A joint analysis of BICEP2 and Planck data including dust polarization uncertainties [9] also claim this contribution due to dust could possibly be higher than the various estimates presented by the BICEP2 team.

Galactic foregrounds subtraction is a major challenge in detecting faint polarization patterns in the CMB. Since the level of signal is extremely small, confusion between cosmological signatures from gravitational waves and instrumental systematics or galactic foregrounds require further complex and more rigorous analysis. Determining whether evidence for primordial gravitational waves is a true detection requires a full-sky map of the polarization from dust, recorded at several frequencies. At present, only Planck can produce such a map. The C-Band All Sky Survey (C-BASS), a project to image the whole sky at 5 GHz, can make detailed maps of the CMB and study diffuse radiation from the Galaxy. C-BASS involves two separate telescopes, one at the Owens Valley Radio Observatory (OVRO) in California, and the other at Karoo in South Africa. Observations from C-BASS would be key to understanding the intricacies of galactic foreground (mostly synchrotron radiation at 5 GHz) subtraction in CMB polarization data.

A sanity check for any cosmological signal is multi-frequency detection. BICEP3, commissioned for 2014-2015, will operate at 95 GHz. Cross-correlation with the Keck array 100 GHz and 150 GHz detectors, will provide a tool to distinguish between the large scale B-mode detection and galactic foregrounds.

The theory of inflation developed by some of the brightest researches of the past four decades is a novel and simplistic theory of the evolution of the universe. On 30 May 2014, Alan Guth, Andrei Linde and Alexei Starobinsky were awarded the prestigious Kavli Prize for astrophysics for their work developing the theory of cosmological inflation. The BICEP2 result, if correct, is a spectacular and historic discovery. In terms of impact on fundamental physics, particularly as a tool for testing ideas about early universe physics, the detection of primordial gravitational waves is completely unprecedented. With good frequency coverage and low noise there are no obvious obstacles for CMB foreground separation. There may also be small patches of the sky which are quite clean, and future surveys should choose carefully the regions of the sky they observe. Overall, we remain optimistic that future B-mode polarization searches will provide powerful constraints on inflationary models.

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The Virtual Atomic and Molecular Data Centre

Prof Derck P. Smits

Introduction

Astronomers from Unisa's Department of Mathematical Sciences have been invited to join an international colloboration that has established a virtual data centre supplying atomic and molecular (A&M) data to the international scientific community. A&M data are of critical importance across a wide range of disciplines, including, but not limited to, astrophysics, atmospheric physics, fusion research, environmental sciences, combustion chemistry and radiation science. Besides the vast range of scientific uses of A&M data, many industries also require A&M data for research and development (e.g. the lighting industry to produce more efficient globes), or to monitor processes during manufacturing. Many of the steps in the manufacture of semi-conductor chips rely on plasma based processes that can only be understood if the collisional and radiative processes are properly understood and quantified at an A&M level.

Many groups world-wide generate A&M data by measurement and/or calculation to address issues of interest to their specific needs. The data generated are often fragmented and only available through specialised and sometimes poorly documented interfaces that are unknown outside a specific discipline or field of interest. Each area has developed its own data repositories and protocols for accessing their data. This can lead to duplication of effort, and limits the full scientific worth of calculations and measurements. Old and inaccurate data could remain in use in some disciplines after improved values have been generated and adopted by other communities.

VAMDC

The Virtual Atomic and Molecular Data Centre (VAMDC, http://www.vamdc.eu) is a European Union Framework 7 funded programme. It is a collaboration between groups involved in the generation, evaluation and use of A&M data. The VAMDC collaboration has built a common electronic infrastructure for the exchange and distribution of a range of diverse atomic and molecular databases using a standard protocol that can be accessed via a single portal. Experience and expertise has been gained from projects such as Euro-VO, the European component of the International Virtual Observatory Alliance, and Europlanet, a European collaboration for research in planetary science.

The VAMDC Consortium is lead by the Observatoire de Paris (France) and has partners from the University of Cambridge, University College London and the Open University (UK), Uppsala Universitet (Sweden), Universitaet zu Koeln (Germany), the Korea Atomic Energy Research Institute (KAERI) (South Korea), Unisa (South Africa), the Tata Institute of Fundamental Research (TIFR) (India) and Universidade de Parana (Brazil). There are also a number of external partners who are not funded by VAMDC, but whose databases form part of the network. Current partners are the National Institute for Fusion Science (Japan), the Electron Scattering and Modelling Group at Flinders University and the Atomic and Molecular Laboratory in Canberra (Australia), the Atomic and Molecular Data Unit of the International Atomic Energy Agency (Austria), the Atomic Spectroscopy Group and the Chemical and Biochemical Reference Data Division at NIST, the Harvard-Smithsonian Centre for Astrophysics and the Jet Propulsion Laboratory (USA).

VAMDC is an architecture made of components that are hidden from the end user, allowing users to access and retrieve data stored in a variety of forms from different sources. Data producers maintain their scientific resources as nodes in the VAMDC network. Data consumers query the network from an online portal. The portal is a search engine interrogating a distributed set of database nodes, and returning links to the nodes that contain the requested information. The data can then be requested and becomes available in a standard machine-readable format.

The effort expended by users in searching for and retrieving data is minimised by the use of the single portal that accesses and interrogates a number of databases. The data are available in a standardised format so that it is not necessary to write a special routine to read data every time a different database is accessed. Software

packages that use A&M data can include subroutines in their codes to retrieve data via the VAMDC portal, thereby ensuring that the latest data is included in their programmes.

A web interface with a simple graphical interface is used to create queries and retrieve data via the portal. The VAMDC Consortium homepage is at http://www.vamdc.eu. From the homepage you can get to the query page and tutorials on how to use the VAMDC portal. On the LHS of the homepage under VAMDC Resources click on the Access to Data > portal link and you will arrive at the query page. To find out how to use the portal, click on the User Support > Tutorial link and you will be taken to a page with some movies in both *.mov and *.asf format that provide an introduction on how to set up a basic query on the VAMDC portal, and how to retrieve the data requested. Complex queries can also be constructed, as described in one of the tutorials.

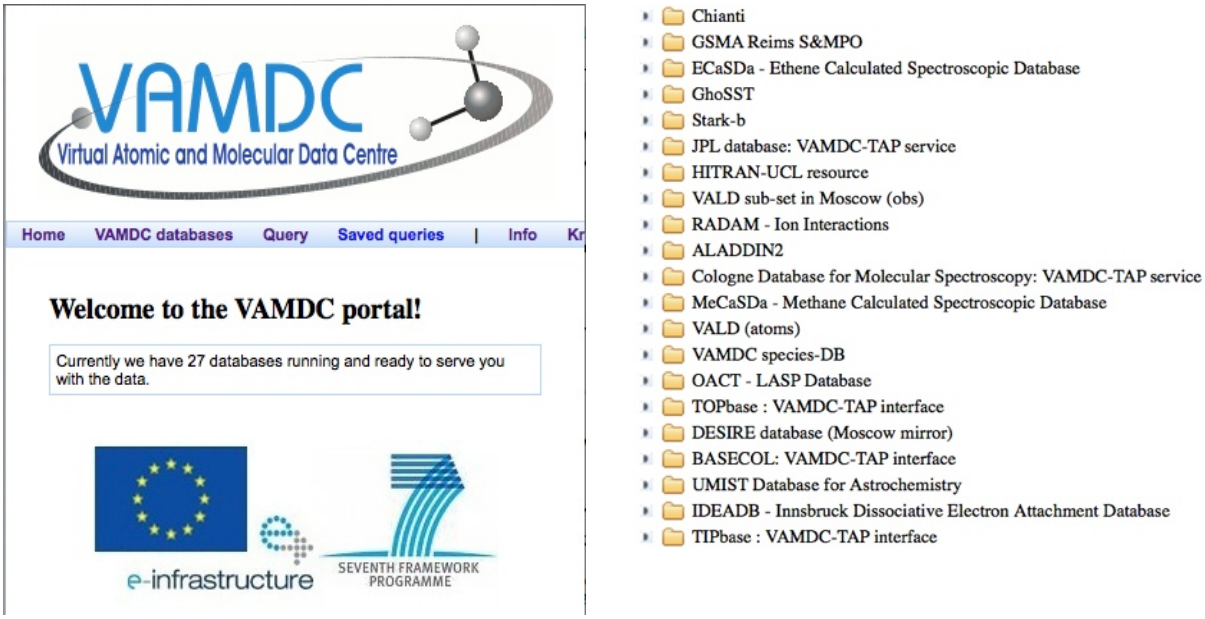

Figure 1. The welcome page of the VAMDC portal and a list of some of the databases currently available.

As of May 2014, the VAMDC portal provides access to 27 A&M databases. Because this project has been initiated and led by astronomers, many of the databases are for astrophysical or planetary science applications. However, the scope of the project is expanding and there are now links to RADAM and ALADDIN2. RADAM is a database on damage to molecules of biological interest caused by exposure to alpha, beta and gamma radiation. ALADDIN2 is a database of A&M data for use in fusion research.

A wide variety of A&M data is available through VAMDC, such as energy levels, central wavelengths, transition probabilities (A-values), oscillator strengths, statistical weights, line broadening parameters, ionization potentials, and electron and proton collision rates. In some cases, data might be available from more than one source, in which case the most appropriate data can be chosen. This also makes it possible to check the reliability and accuracy of data across the different nodes.

The data is by no means complete, so any new calculations or measured quantities would be welcome. Any producer of A&M data can join the VAMDC infrastructure by

- including their data in an existing database that is a partner of VAMDC
- creating a new database hosted by a partner of VAMDC
- creating a new node in the VAMDC infrastructure.

The core of the VAMDC information system is the registry. It consists of a database holding metadata that describes all the VAMDC resources. The method for exchanging data within VAMDC uses a modified version of the International Atomic Energy Agency's XML Schema for Atoms, Molecules and Solids (XSAMS, see www.xsams.org) called VAMDC-XSAMS. Physical states of atoms, molecules, ions and particles can be specified with any number of levels of details in different coupling schemes. Processes between states can be described using an initial and final state together with a process type. Because the origin and history of the

data are necessary for quality purposes, the schema imposes strict requirements on the traceability of the data, and contains information on data sources and methods used to generate the data. These references can be used to credit the original data producer.

To ensure the reliability of the system all registered services are monitored, and a validator has been developed to check the compliance of services to the VAMDC standard.

VAMDC was established in 2009. Members from Brazil, India, Korea and South Africa were invited to join the consortium in 2013 with the specific aim of connecting to audiences in developing nations. Unisa's role is to advertise the portal to potential A&M data users in Africa, and to provide training if required. Any generators of data are encouraged to get their data included in VAMDC through one of the options discussed above. Groups interested in finding out more about VAMDC are welcome to contact the author to arrange for a presentation and/or training session on how to use the portal or join the VAMDC infrastructure.

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Opportunities

MSc and PhD Opportunities with UKZN

The University of KwaZulu-Natal has positions for MSc studies in the High Energy Physics on the ATLAS Experiment For more information please contact Dr. Sahal Yacoob Yacoob@ukzn.ac.za

The University of KwaZulu-Natal has positions for MSc, PhD, and Post-doctoral studies available. More information may be found here:
http://caes.ukzn.ac.za/Bursaries.aspx

The research group of Prof T. Konrad at UKZN offers MSc and PhD positions in Quantum Computing and Quantum Communication with photons as well as in Quantum Measurement and Control of ions. Contact Prof Konrad:
konradt@ukzn.ac.za

ICTP Prize 2014: Call for Nominations

Nomination deadline is 30 September 2014

ICTP Prize 2014: Call for Nominations

20/03/2014 - Trieste

It is time to nominate young researchers from developing countries for the 2014 ICTP Prize. The prize recognizes outstanding and original contributions to physics by researchers under 40 and includes a sculpture, a certificate, and a cash prize of 3000 euros.

Past winners include Ashoke Sen (1989), the Indian theoretical physicist who has been awarded the 2012 Fundamental Physics Prize, and the current ICTP Director Fernando Quevedo (1998). The 2013 ICTP Prize was shared by two women: Yasaman Farzan (Iran) for her theoretical contributions to the physics of neutrinos, and Patchanita Thamyongkit (Thailand) for contributions to development of photovoltaic research.

The deadline for nominations is 30 September 2014. Detailed information on how to nominate a candidate is available on the ICTP Prize Page. Additional information may be obtained by writing to ictpprize2014@ictp.it.

Completed nominations must be submitted along with a signed and dated cover letter by 30 September 2014 by email (ictpprize2014@ictp.it), regular mail (ICTP Prize 2014, Director's Office,
ICTP,
Strada Costiera 11,
34051 Trieste, Italy) or fax (+39 040 2240 410).

The complete list of past winners and their award citations are available on the ICTP Prize Page.

More information: http://www.ictp.it/about-ictp/media-centre/news/2014/3/ictp-prize-2014-call-for-nominations.aspx

Upcoming Conferences & Workshops

Bring International Physics Conferences to South Africa

The SAIP Office would like to help South African physics community to bring international conferences and workshops to South Africa. The SAIP can help with hosting these conferences as well as preparing bidding documents, budgeting and fundraising.

The SAIP office has helped in hosting very successful international physics conferences and workshops.

Please email the conferences you want us to help bring to South Africa to
info@saip.org.za

SAIP 2014 Annual Conference

The 59th Annual SAIP Conference will be hosted by the University of Johannesburg and takes place from Monday, the 7th July to Friday 11th July 2014.

Key deadline dates are;

IMPORTANT DATES:

03 Feb 2014 - Abstracts Submission and Registration Opens

11 April 2014 - Abstract Submission Closes

09 May 2014 - Acceptance Notifications

06 June 2014 - Registration Closes

20 June 2014 - Payment Closes

27 June 2014 - Paper Submission Deadline for Proceedings

19 Sept 2014 - Deadline for Reviewed Papers Corrections

The 4th East African Astronomy Workshop (EAAW-IV)

https://sites.google.com/site/eaasconference2014

University of Rwanda -College of Education (Former Kigali Institute of Education) Kigali-Rwanda: June 30- July 04, 2014.

The series of workshops in Astronomy in East Africa began in 2009 during the International Year of Astronomy (IYA2009). The first workshop was held in November 2009 in Nairobi, Kenya and was supported largely by the International Astronomical Union/ Teaching for Astronomy Development (IAU/TAD), Developing Astronomy Globally (DAG), SAAO, University of Nairobi and the International Science Programmes (ISP- Upsalla University). Most of the resource persons were largely drawn from outside the region, including USA and South Africa. The second workshop was held in February 2011 in Addis Ababa, Ethiopia and the resource persons were drawn largely from the East African region with only two others from South Africa, led by the Director of OAD, Mr. Kevin Govender and Dr. Petri Vaisanen of SAAO. The sponsorship came from the IAU, SAAO and the Ethiopian Space Science. Society. The third workshop was held in November 2012 in Kampala, Uganda. The resource persons were drawn from IAU/OAD, SAAO, SA SKA, African VLBI network project and from South Africa DST.

The fourth workshop, being organized by the East African Astronomical Society (EAAS) is scheduled from June 30 up to July 04 2014 at University of Rwanda- College of Education (former Kigali Institute of Education), Kigali-Rwanda.

The purpose of these workshops is to strengthen capacity building in Astronomy and Astrophysics and Space Science in general and also provide a forum for astronomers from the region to train young and upcoming scientists. It provides an opportunity for exchange of ideas, cross border co-supervision and sharing of resources. There already exists a Bachelor's degree programme in Astronomy and Astrophysics at the University of Nairobi, Kenya and a number of other universities in the region are in the process of curriculum development of the same. The Ethiopian Space Science Society is running two 1-m class optical telescopes at Entoto Observatory near Addis Ababa. There is project to transform old telecom dishes into radioastronomy antennas to make a strong VLBI African network.

None of the individual countries have enough manpower and the resources to run programmes in astronomy on their own and this calls for networking and sharing of expertise to teach and supervise students across East Africa.

Outreach Opportunity – TEDxCERN

We would like to ask for your help on spreading the word among the communications and/or outreach representatives of the universities in your country involved in experiments/research activities at CERN.

After the success of the first TEDxCERN last year, CERN has decided to organize another event this year on 24 September 2014 under the theme Forward – Charting the Future with Science (http://tedxcern.web.cern.ch/) . The event will provide a unique platform for the world's leading researchers, scientists, developers, designers, and artists to share and build bold visions of the future. We want to pass the message that science is essential in confronting the major issues and challenges facing society today and would like to encourage all the institutes involved in the research programme at CERN to stream the event live.

Last year more than 10,000 viewers were watching the event through live webcast either from our homepage or from one of the viewing parties which were organized by 24 CERN associated institutes around the world. Streaming the TEDxCERN event is an excellent opportunity for universities to engage with their local communities about science and STEM subjects. The universities can build their own event around the live feed from CERN which will be supported by us with exclusive material and ideas for the event.

Anyone interested in hosting a TEDxCERN@Yourinstitute should please contact webcast@tedxcern.ch.

Quantum Simulations and Quantum Walks

This is the fourth of a series of conferences which were organized previously in Valencia, Okazaki, and Pisa. In the upcoming conference in Durban emphasis will be given to the properties of quantum walks also in relations to quantum simulations.

The conference will take place from 24 to 28 November 2014. at the PumulaBeach Hotel.

Important Dates

Registration deadline: 29 August 2014
Submission of abstracts: 5 September 2014
Hotel deadline: 19 September 2014

Invited Keynote Speakers

S. Attal (University of Lyon)

D. Bernard (Ecole Normale Supérieure)

D. Berry (Macquarie University)

A. Joye (Institut Fourier)

O. Muelken (University of Freiburg)

J. O'Brien (Unviersity of Bristol) (TBC)

T. Tate (Tohoku University)

A. White (University of Queensland) (TBC)

Conference Organization

The conference is organised by Francesco Petruccione (UKZN), Yutaka Shikano (Institute for Molecular Science and Chapman University) as well as Ilya Sinayskiy (UKZN and NITheP)

Sponsors

National Institute for Theoretical Physics-Centre for Quantum Technology (UKZN)

For more information and to register visit the website.

16th Southern African Association of Science and Technology Centres (SAASTEC) Conference Nov 2014

Science Centres – Lighting up the way! The 16th Southern African Association of Science and Technology Centres (SAASTEC) Conference will be held at the Nelson Mandela Bay Science and Technology Centre in Uitenhage from the 17 – 20th November 2014. The theme for the conference this year is "Science Centres - lighting up the way". The sub-themes have been aligned to the 7 goals from the Science Centre World Summit 2014 that was held in Belgium earlier this year. Deadline for abstracts is 31st July 2014. Who should attend this conference? Professionals from science and technology centres, national research facilities, innovation support centres, museums, planetariums, aquariums and art galleries as well as researchers, educators, teachers, government officials, administrators and policy makers involved with the public understanding of science, mathematics and technology (PUSET), curriculum developers and subject advisors. Sponsors, industry partners, stakeholders and other interested members of the community are also welcome. For more details please visit http://www.saastec.co.za or contact Ginny Stone squigglez@telkomsa.net.

WORKSHOP ON DISCOVERY PHYSICS AT THE LHC KRUGER-2014

December 1 - 6, 2014, Protea Hotel Kruger Gate Portia Shabangu Road, Skukuza, Mpumulanga, South Africa

We are pleased to announce the Third Biennial "Workshop on Discovery Physics at the LHC" (KRUGER 2014).

The Workshop will be held at the 4-star Protea Hotel Kruger Gate, just 100 meters from the entrance to the Kruger National Park.

Please find details in the conference web page:
http://www.kruger2014.tlabs.ac.za.

The conference aims to promote scientific exchange of new results and development of novel ideas and models related to the physics of the LHC.

The following topics will be covered:

- Particle Physics;
- Heavy Ion Physics;
- Physics after the discovery of the Brout-Englert-Higgs boson.

Accommodation, registration, abstract submission and other practical details can be found on the web page. Attendance will be limited to about 100 participants because of the number of available rooms in the hotel.

Students are encouraged to also take part in a related workshop/school on ``Hot and Dense Nuclear & Astrophysical Matter - HDM2014'' which will be organized by Professor Azwinndini Muronga (amuronga@uj.ac.za) at the University of Mafeking November 24 - 28, 2014.

Other related events of interest to students are: ``Chris Engelbrecht School in Particle Physics'', January 12 - 21, 2015, and the ``High Performance Signal and Data Processing'', January 26 - 30, 2015.

Limited funding for South African students is available.

Physics Comment Editorial Policy

Deadline for submissions for the September 2014 issue of Physics Comment is 31. August 2014

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:
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).
The author allows PC to edit the work for clarity, presentation, including making appropriate hypermedia links within the work.
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.
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. 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.
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/