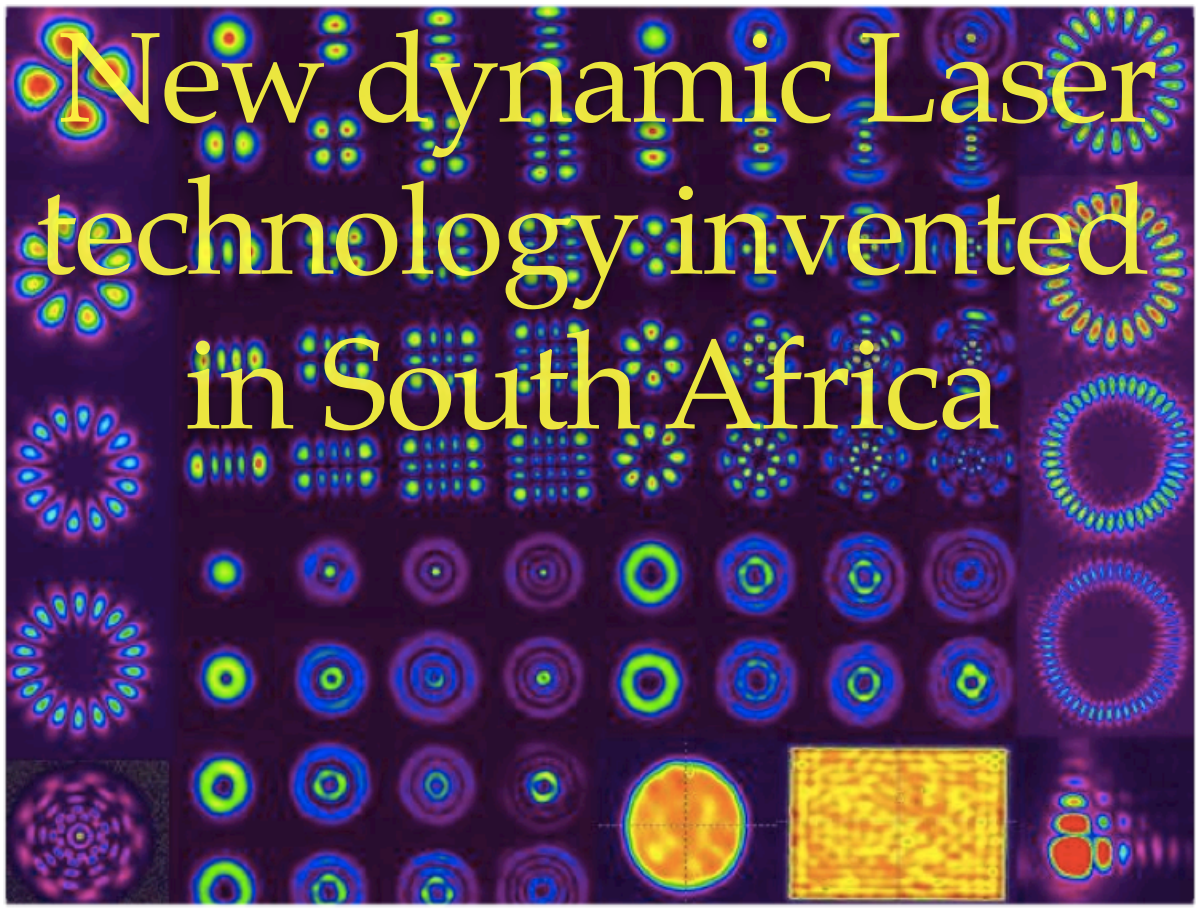
Vol 5, Issue 2, September 2013 Webpage EmaiL

Physics Comment

A Southern African Physics Magazine



A Quarterly Newsletter Issue No 3 - Spring 2013

Successful SAIP conference at UNIZULU

400 delegates witnessed 12 invited speakers, book and review launches and a new SAIP Council. The next host is UJ.

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Silver Jubilee Medalist 2013

Dr Amanda Weltman says she is not only a physicist but "also a normal mom". The award shows she is an outstanding physicist. **Page 5**

The Education Pipeline Problem

What are the consequences of the Review of Undergraduate Physics Training in SA?

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Secure digital communication

In the midst of the eaves-dropping scandal by secret service NSA the future could be secure and Quantum **Page 24**

Editor: Prof T. Konrad

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Editor‘s Note

The 58th annual SAIP conference, hosted by the University of Zululand in Richardsbay, was in my opinion, a pleasant and well organised event (p. 4). SAIP members heard the final SAIP President report from Prof Simon Connell, who passed the baton on to his successor Dr Igle Gledhill. The report (p. 7) summarized the situation of physics in South Africa and showed that nine years after the *Shaping the Future of Physics* review, many of the 14 recommendations given by an international team of experts, have been implemented and will continue to benefit our discipline. It is informative and impressive to read what has been achieved, during the presidency of Prof Simon Connell alone, when the *South African Institute of Physics* obtained a new professional structure, (p. 7). For example, it was agreed to transform SAIP into a Professional Body. In addition, Prof Connell also identified the items on the SAIP agenda that still have to be accomplished.

The conference in Richardsbay saw the release of the national report on physics undergraduate training in South Africa. It was generally agreed that the competence and number of physics graduates currently represent the main challenge faced by physics in SA. A “special subject” section in this issue of Physics Comment (p. 15) is dedicated on how to deal with the so-called education pipeline problem.

Moreover, this issue of Physics Comment contains an article on the recent invention of a digital laser in Pretoria and a collection of other articles, which I hope you will enjoy.

With best wishes
Prof Thomas Konrad

Caption of picture on cover page: Intensity distributions of light modes emitted by the new digital laser.

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.

Part of the Local Organizing Comittee, the SAIP Council and the invited international speakers.

News from Africa

University of Zululand Hosts Annual SAIP conference

by Brian Masara, SAIP Office, Pretoria.

The 58th Annual Conference of the South African Institute of Physics (SAIP) was hosted by the University of Zululand (UNIZULU) at the Richards Bay Campus from 08-12 July 2013. Over 400 delegates attended the conference.

Speaking on behalf of UNIZULU Vice-Chancellor Fikile NM Mazibuko, Professor Rob Midgley, Deputy Vice-Chancellor, Research and Innovation said: "UNIZULU's trajectory is focussed on creating an enabling environment to ensure we produce leaders across fields and productive citizens who will contribute to new developments in Africa and the world" . He said the conference was one of the critical sources of encouragement for UNIZULU. Prof Midgley added that the University was focussed on developing new platforms for exchange of ideas and discussion 'and we believe that together we can strengthen Africa's response to global change through research and technology.'

Three winter schools covering Biophysics, High Energy Physics and Science at Synchrotrons preceded the conference. Major highlights at this year's event included the launch of the National Report on Physics Undergraduate Training in South Africa and the book "History of Physics in South Africa".

Prof Simon Connell (right) presents a copy of the book History of Physics in South Africa to host Prof Rob Midgley (left).

As a leading institute of higher learning, UNIZULU is focused on expanding academic interest to build and strengthen research capacity, broadening current offerings, establish new partnerships and create multiple platforms to further the exchange of information and encourage discourse and debate. To ensure a value added experience, 11 plenary sessions were held with international speakers who are distinguished leaders in their respective fields of expertise.

The SAIP2013 book of abstracts can be accessed via this link .

The SAIP2013 was officially opened by the Honourable Mayor of uMhlathuze City (Richardsbay), Cllr E. F. Mbatha.

Conference delegates in a plenary session.

The conference closed with a banquet where students were recognized for excellence in their research. The major award at the SAIP 2013 was the Silver Jubiliee Medal that was awarded to Dr Amanda Weltman (see article below). The conference guests, among them the Honourable Mayor of the uMkhanyakude municipality, Cllr S.J. Vilane, witnessed the closing ceremony as the batons passed on in form of traditional knobkerries from the outgoing SAIP president, Prof Simon Connell, to the new one, Dr Igle Gledhill as well as from the UNIZULU Local Organizing Committee to the one of next host, the University of Johannesburg (we report below).

New SAIP Council Elected

by Prof Thomas Konrad, SAIP Council Member, Osnabrück (Germany)

On the last day of the SAIP conference, a newly elected SAIP council took over from the former council under President Prof Simon Connell. The transfer of responsibility and power was symbolized by the handover of a traditional Zulu fighting and hunting stick - a so-called isaGila or knobkerrie - from Prof Connell to the new president Dr Igle Gledhill during the conference banquet. The audience might have seen the start of a new tradition which was invented by the Local Organizing Committee from the University of Zululand, who first handed over the knobkerrie to former SAIP president Simon Connell at the beginning of the ceremony.

A similar ceremony was introduced to mark the passing of the baton from this year's Local Organizing Committee to next year's.

The new SAIP council consists of the following members:

The Executive

President: Dr. Igle Gledhill (CSIR)

Passing the baton on from former SAIP president, Prof Simon Connell (left) to his successor Dr Igle Gledhill (right).

President Elect: Prof Frikkie Scholtz (NITheP)

Secretary: Dr. Malebo Tibane (UNISA)

Treasurer: to be filled (Japie Engelbrecht to continue till end of 2013)

Immediate Past President: Prof Simon Connell (UJ)

Additional elected and co-opted members:

Prof. T. Konrad (UKZN) (Marketing and Outreach)

Prof. I. Basson (UNISA) (Conferences Management)

Prof. K.K. Muller-Nedebock (US) (Awards)

Prof. A. Muronga (UJ) (International Cooperation)

Prof. P.A. Woudt (UCT) (Astronomy Liaison)

Dr. M. Diale (UP) (Industrial Liaision and Fundraising)

Dr. S. Ramaila(UJ) (Education)

The new SAIP President Dr Igle Gledhill gives her inaugural speech at the conference banquette.

SAIP Adopts New Constitution

by Dr Malebo Tibane, new SAIP Honorary Secretary, Pretoria

It is my pleasure to inform you that a new constitution and by-laws of SAIP were adopted on the 12 July 2013 at the University of Zululand.

The background to this is that, the SAIP is in the process of registering with SAQA as a Professional Body and this also involves the development of a Physics Professional Designation. SAIP is developing the Professional Physicist (Pr.Phys) designation. A member registered with SAIP as a Professional Physicist can use the letters Pr.Phys after their name e.g. George Brown (Pr.Phys).

Download the current updated versions here: http://www.saip.org.za/index.php/members/constitution4
In order to achieve the above it was necessary for the SAIP to add new clauses to its constitution and bylaws. The proposed changes to the constitution and bylaws were decided by a secret vote by SAIP members. The results of the constitutional change were announce on 12. July 2013 at the AGM held in Richards Bay at University of Zululand and they were 100% in support of the changes.

Malebo Tibane

Jubilee Silver Medal 2013: And the Award goes to...

from Citation for 2013 Jubilee Silver Medal: Dr Amanda Weltman

The 2013 jubilee silver medal is awarded to ***Dr Amanda Weltman*** for the original and high impact research done as a young scientist, her contribution to outreach and her contribution to promote the role of women in physics and mathematics.

Dr Amanda Weltman with her family.

Dr Weltman completed her undergraduate and honours studies at the University of Cape Town. After this she moved to the University of Columbia where she obtained her MA and MPhil in Physics in 2003 and 2004, respectively, and finally her PhD. in 2007. The latter was under the supervision of Brian Greene. After this she spend two years at the Center for Theoretical Cosmology at the University of Cambridge before returning to the University of Cape Town as lecturer and later senior lecturer.

Dr Weltman has published 17 articles in her short research career. Remarkably 5 of these were in Phys. Rev. Lett. Her papers received more than 1000 citations. Her three most cited papers received 406, 385 and 192 citations, respectively. This, together with an overall h-index of 11, is remarkable for a young scientist. In recognition of these achievements she has received numerous awards, prizes and fellowships, including the prestigious President Award of the NRF.

By awarding the 2013 Jubilee Silver Medal to her, the SAIP recognizes her standing as a young scientist and her potential as a future leader in her field.

Free SAIP Membership for 3rd Year and Honours Physics Students

by Brian Masara (SAIP Office)

There will be a limited run of hard copies for the initial release, as well as a free electronic version available to SAIP members. Should you wish to purchase a hard copy at cost price please reserve this by writing to the SAIP Executive Office. Further details on the release are also available from the Executive Office.

The SAIP Council passed a resolution to extend free membership all 3rd Year Physics students and all Honours Physics Students. In order for 3rd year and honours students to be given free SAIP membership they must do the following.

- Approach their supervisor or physics head of department and ask them to send a request to SAIP
- The HoDs / Supervisors can choose to make their students free SAIP members
- The supervisor or HOD can send an email with the students' names and email address to SAIP on info@saip.org.za
- The 3rd year and honours students will have the following benefits
- Receive all SAIP electronic communication such as the Physics
- Comment magazine and adverts for scholarships, conferences and jobs.
- Attend the SAIP annual conference as student membership rates

This subscription will be valid for 1 year from January to December only hence for honours students they can ask their supervisor/HoD to renew it every year in January.Physics in South Africa

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.

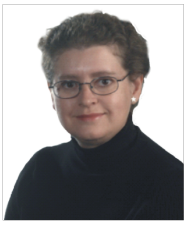
SAIP membership includes any physicists who graduated with at least physics related degree working in either; industry, commerce, government, academia, research, theoretical physics, experimental physics, and uses physics skills and thought processes in their job/career.

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

SAIP Annual General Meeting President's Report – 13 JULY 2013

Speech of SAIP President Prof Simon Connell at the AGM 13. July 2013, Richardsbay

Good afternoon, Colleagues.

Firstly, congratulations and thank-you to our hosts, the University of Zululand, the Local Organising Committee and its Chair, Prof Muzi Ndwandwe, co-chairperson Mr Thulani Jili and the SAIP Office with the Executive Officer, Brian Masara, for their organisation in making the 56th Annual Conference of the SAIP a success. We are in the beautiful surrounds of the verdant, warm and unspoilt North Western coast for the first time, and the conference arrangements have impressed us.

2013 Has Been Year Of Consolidation And Growth

In South Africa, although we are developing country, the last decade has seen dramatic improvements in the Science System. Specifically, there is an unprecedented improvement in the health of the discipline of physics, which is on a new growth trajectory. The award of the SKA site decision is just one aspect of this positive trend. We see increased scholarly output, very much improved access to local and international large-scale research infrastructure and the modernization of local research laboratories and other research infrastructure. Linkages within South Africa and globally between academics are well established, and there is a particularly good rapport with the Department of Science and Technology. The main threat to the sustainability of the positive trend is the education pipeline. This is now a most crucial point to be addressed.

It is nine years since the Shaping the Future of Physics (SFoP) review, which led to 14 main recommendations, of which, 13 have been implemented to at least a significant degree, and in some cases a spectacular degree. The SFoP review has to some extent achieved its goal of setting the discipline on a new path. A short summary of the status is provided. For further details, please consult the SAIP Executive Officer, Mr Brian Masara and the SAIP web site.

The fourteenth recommendation was treated by Council with the highest priority and it soon saw the establishment of the SAIP Executive Office, lead by Mr Brian Masara as the Executive Officer, assisted by Mrs Linette White as secretary. The position of a Project Officer is open at the moment. This has been a most important enabling step, and a host of SAIP projects are run from the Executive Office.

The second recommendation on Tertiary Education is in the course of being addressed. We have completed the development of the Draft Benchmark Statement and at this year's Annual Conference we launched the Report on the Review of Undergraduate Physics Training. This matter is very important and is further discussed later in my report.

The third recommendation on the Marketing of Physics in Industry is treated by Physics 500 project, and from this year also the Physics in Industry Day project. Council is also in the process of visiting physics related industries. The Forum for Applied Physics is experiencing a period of strengthened partition.

The fourth recommendation on the Public Understanding of Science was supported by the award of funds leading to several programmes. The SAIP contribution supports other stakeholders in this area and achieves substantial leverage using the expertise and capacity within the membership and project management from the SAIP Executive Office. This has seen the direct physics participation in outreach events, the development of materials and the mobile laboratory project, amongst others.

The fifth recommendation on Human Resource Development may also be seen as being handled in several ways. The SAIP Executive Office school, workshop and conference organising capacity greatly facilitates the participation of students and the focus is on activities relating to opportunities for students and enhancing their participation. The various SAIP digital media also collate and advertise opportunities for students. The SAIP Annual Conference, together with its new capacity for published proceedings represents considerable investment in the outcomes for the students. The SAIP programme Women in Physics in South Africa

(WiPiSA) has also focussed on increasing the number of women involved in Physics. The SAIP Executive office assists not only in the organisation, but also in the fund raising and the strategic thinking associated with these activities.

The sixth recommendation requested a Research Information Network. This has in part promoted the creation of the high speed SANReN network (1 and 10 Gig). This represents a large new investment in cyber Research Infrastructure costed at R660M. Over 120 research and training related institutions are now connected.

The seventh recommendation promoted the establishment of a National Research Digital Library. The DST have recently reported that by the end of the year, the "e" in South African National Research Network (SANReN) will be "capitalised", with the launch of this library, giving equal and national access to electronic online research journals, adding the "Education" aspect to justify this new acronym.

The eighth recommendation concerned the Flagship Projects. A partial list includes iThemba, the Photonics Initiative, the Astronomy facilities including the SKA, the Centres of Excellence, the progammes on bio-physics and nano-science amongst others.

The ninth recommendation concerned Long-term Strategy development. The SKA fits within this plan, as do the two major foresight exercises now in process: the Decadal Plan on Astronomy (co-ordinated by the Astronomy Desk) and the Research Infrastructure Roadmap (co-ordinated by the DST and the NRF). There have been several steps prior to this in the process of long-term strategy development.

The tenth and eleventh recommendations aimed to secure Small Science and the associated Infrastructure and Equipment. These have been covered by the NEP and NEPP grants of the NRF, as well as recapitalisation and emergency repair grants, totalling more than R1.5B since the SFoP Review. Notable developments have been several electron microscopes, including the HR-TEM at NMMU, assorted X-ray diffraction and scanning equipment countrywide and the development of multi-isotopic Accelerator Mass Spectrometry at iThemba (Gauteng), now nearing completion. Although there are many demands in this arena, the community has experienced a significant improvement in the recapitalisation of small science.

The twelfth recommendation concerned Theoretical Physics and the establishment of the National Institute of Theoretical Physics (NITheP) has been a significant, bold and visionary step.

The thirteenth recommendation aimed to promote Technological Spin-off and Innovation. Various funding instruments include the NRF administered THRIP grant system which promotes joint academic–industrial research, the Technology Innovation Agency which also manages several funding programmes and the DST managed Innovation Fund. Various colleagues have been involved with these funding sources. There is considerable room for this landscape to be optimised. The SAIP runs Entrepreneurship Workshops in partnership with the IoP.

The implementation of these recommendations as described has lead to a substantial improvement in the local research infrastructure. There has been a corresponding improvement in access to international large-scale research infrastructure, to be mentioned further below. This is also accompanied by the development of improved communication and partnership between the SAIP and the DST and also the DHET.

However, mention of first recommendation on Primary and Secondary Education was reserved for the end of the list. The crisis in the poor preparation of South African school leavers continues to deteriorate. The Report on the Review of Physics Training estimates this can be quantified as being between one and two years behind the level that is required for University entrance. The Council has identified the "Educational Pipeline" as the most important issue threatening the sustainability of the improving health of the discipline of physics. It needs to be urgently addressed. The pipeline (leakiness) and its exit standards can be addressed through the implementation of the recommendations of the Review of Physics Undergraduate Training Project. The design of the implementation process is still being constructed, in a way that will continue to reflect the principles of inclusivity, consultation and buy-in from the community. The input standards aspect of the pipeline will be addressed by the Teacher Training Project, which saw two pilot events this year, in partnership with the IoP.

The project will be further developed and resourced. The implementation will include a process of auditing and partnering with the many other existing projects.

Developments in Astronomy will be treated in more detail. Following the long awaited, much anticipated announcement of the award of the SKA on May 25th, this became a mega project within our Science system, and certainly also for Physics. The SAIP seeks to secure the strong connection of astronomy to physics, and to participate with all partners in achieving the scientific, developmental and technological goals of the SKA project. The project, large as it is, is also just a component of the South African Astronomy programme, which includes the optical, radio and gamma-ray facilities: SALT/SAAO, HartRAO/MeerKAT/SKA and HESS2/CTA. The astronomy community is deeply embedded within the Physics community. In fact, as we develop our realisation of the importance of multi-wavelength astronomy, we also extend the concept to multi-messenger astronomy. The astronomy talks at the conference of course evidence the very intimate connection to fundamental physics process. The overlaps include nuclear and particulate matter and dynamics in extreme conditions, the nature of gravity, dark matter, dark energy, the physics of the early universe and the possibility of life elsewhere in the universe. Additional connections arise due to the development of improved and also novel instrumentation and the trend continues towards high performance computing and big data. These are common themes for particle physics, nuclear physics, materials science and other sub disciplines. The SAIP interaction is mediated via several aspects. There is the Division for Astrophysics and Space Science, also a specific Portfolio on Council for Astronomy Liaison, and the SAIP Executive Office assists with the management and operation of various projects. The SAIP played a role as the "Voice of Physics" in shaping the governance and management of Astronomy and Space Science. Currently, Prof Nithaya Chetty, a former President of Council, is serving as the NRF Group Executive of Astronomy and Prof Ramesh Bharuthram, is serving as the Head of the DST Astronomy Desk. The Decadal Plan for Astronomy is being developed, co-ordinated by the Astronomy Desk and the long term Research Infrastructure Roadmap is being co-ordinated by the NRF and the DST. Other news is that the governance of astronomy in the medium term will be placed in a new sub- agency of the NRF, early in 2014.

Again within the theme of large-scale infrastructure, the SA-CERN programme and the SA-JINR programme have been continued and are flourishing. Taking the theme of accelerator-based facilities further, the SAIP has played an important role in developing the use of (synchrotron) light sources as premier multi- and inter-disciplinary research tools by participating in developing the user base, the capacity building, the strategic thinking and the liaison with the stakeholders. In particular, the Executive Office assisted in the planning of the December 2011 Strategic Workshop, the compilation of the Strategic Plan, and is now busy, together with Sekazi Mtingwam and local experts, in finalising the Business Plan. A highlight was the signing ceremony on the 21st May 2013 whereby South Africa became an Associate Member of the ESRF. An online application system for mobility for accessing other synchrotrons was also opened at the NRF. The SAIP Executive Office and iThemba LABS are both assisting in the planning of the next Science @ Synchrotrons workshop to be held in the second week of February in 2014.

Executive Office

The SAIP Executive Office has added tremendous capacity for the SAIP. It has already been introduced in the discussion above. Looking back we realise the establishment of the Executive Office ushered in a period of massively enhanced capacity to operate a host of programs, which have been very beneficial to the health of Physics.

The Office has developed an impressive conference organising capability. It includes the planning, the logistics, the arrangements, delegate liaison, special student treatment, assistance with fund raising, all IT aspects including the web-site, the INDICO Conference management system, support for all financial aspects, and assistance in evaluation and reporting. I want to recommend this service to you. If you use the SAIP Office as your Conference Organising partner, you will both enjoy a wonderful conference organising experience and be supporting the discipline.

The SAIP Office is supporting the Biophysics Project (workshops, outreach, proposals), The Entrepreneurship Programme (workshops), the Women in Physics Programme (support, workshops, outreach), the Marketing

and Outreach Programmes (many projects), the Physics Teacher Support Project (educator development projects), the Physics Graduate Database Project (tracking and reporting), the Physics 500 project (industry networking), the Mobile Physics Laboratory (outreach), the SAIP Gift Shop, the interactions with various other international organisations, the interactions with the NRF, DST, and other departments, the support for the Review of Physics Training project and for the project to develop the Professional Body Registration and the Professional Designation. There are a host of other activities. None the least of these is a campaign to build the financial sustainability of the office based on developing the relationships with industry stakeholders in the health of physics. In early July, there was a successful SAIP Council meeting with the Minister (DST) on this matter. We are indeed appreciative of the performance of the Office and indebted to the SAIP Executive Officer and the Office staff.

Conferences

South Africa through SAIP will host the 9th International Workshop on Adaptive Optics for Industry and Medicine will be held at STIAS in Stellenbosch from 2 – 6 Sept 2013. This Annual Conference of the SAIP in 2013 has attracted 420 delegates, including 11 plenary speakers of which 8 are visitors from aboard. There are 8 colleagues from Africa north of us. The student participation is healthy as usual, with 266 students, representing 63% of the delegates. There has been an excellent cohort of invited plenary speakers, who have delivered outstanding lectures. We all look forward to the banquet, where the top performing students will be recognised, and indeed, the second most significant award of the Institute, the Silver Jubilee Medal, will be bestowed on one of our colleagues.

The hosts for SAIP 2014 will be the University of Johannesburg.

Review Of Physics Training

This very important project was born during the Heads of Physics Departments meeting at the Polokwane SAIP Annual Conference on July 2008 out of the concerns for the poor quality of the entering students and their inability to master physics of an appropriate standard. The meeting adopted a proposal with three phases: Firstly, the development of the Benchmark Statement, secondly, a Review leading to recommendations and thirdly, the implementation of the recommendations. A widely accepted very mature draft Benchmark Statement has been available since late last year. The Review component was carried out as a partnership between the SAIP and the Council on Higher Education (CHE). A Planning Committee consisting of both CHE and SAIP members worked on developing the procedures and documents for the Review. The Planning Committee consisted of Rehana Vally (CHE, Director of National Reviews), Edmund Zingu (now late, SAIP, Leader of the Review of Physics training project), Sam Ramaila (SAIP, Chair of the Division for Education and Chair of the Council Education Committee) and Tom Netshisaulu (SAIP, Member of the Council Education Committee). A period of wide regional and national consultation followed leading to the development of the document, “Criteria for Physics Review”. These criteria were used in a generating Departmental Self Evaluation Reports. Successive regional and national meetings transformed these to Regional Reports and then to a National Report, which was completed in March 2013. A Group of Experts (Prof Craig Comrie (Chair), Dr Joseph Asante, Professor Makaiko Chithambo, Dr Mmantsae Diale, Professor Moraal, Professor David Wolfe) analyzed the Reports and ultimately compiled the “Review of Undergraduate Physics Education in Public Higher Education Institutions” which included a list of Recommendations. The Group of experts were also assisted by Professor Ramon Lopez (University Texas Arlington), and Professor Carl Wieman (University of British Columbia). The report was launched and discussed in several different contexts at the SAIP Annual Conference over the last few days. The entire community will now also be able to be involved in the analysis and implementation stage. The details of the broad inclusive consultative process for this are still to be finalized. The SAIP will then drive the implementation of the Recommendations. We have every expectation that this process will ultimately have the same very positive impact on the health of Physics, as the Shaping the Future of Physics project had nearly a decade ago.

Prof Edmund Zingu passed away on April 20 2013 while on active service as leader of the project. His obituary may be found on the SAIP web site. The SAIP recognises that he lead the process until his passing with deep dedication, a deft hand and a lifetime of wisdom. We also express our appreciation to Dr Sam Ramaila and the rest of the Council Planning Committee.

Professional Body

In order to increase its impact and contribution to the development of physics and its related disciplines, the SAIP has proceeded with the application to South African Qualifications Authority (SAQA) for recognition as a Professional Body and for the Development of a Professional Designation. This matter has been thoroughly discussed in several of the SAIP electronic media, and at the previous AGM. The Constitution and the Bylaws were modified to accommodate this development, describing our Professional Designation and our system for Continuous Professional Development (CPD). The membership voted these changes in today. We therefore now qualify as a Professional Body with a Professional Designation (P.Phy.), and we expect that SAQA will ratify this soon. The Office will be further resourced, and a partnership with SACNASP further developed, in order to carry out the increased scope of activities.

Graduate Database

The SA Physics Graduates Database has once again continued to grow during the past year, and there are currently 1051 graduates registered. The database is used and valued by the DST and NRF, who mine it (without compromising privacy) for reports on the demographics and trends which are useful in determining interventions and formulating programs. The Graduate Database is our opportunity to promote our discipline to the DST, the NRF and society at large, and to really evidence the value of a physics training. It will only be successful if we all co-operate to encourage our departments and students to keep it up-to-date. Please contact the SAIP Executive Office for further information.

Membership

The membership benefits have been discussed at the AGM and are also available on the SAIP web site. Furthermore, it is increasingly well established that the SAIP has played an important role in developing the health of the discipline. All current members are urged to encourage colleagues and students who are not yet members to apply for membership. The forms are available on the SAIP web site. Please note that membership is free for 3rd year and Honours students, and it is heavily discounted for post graduate students. Our membership

History of Physics in South Africa

Council has commissioned a History of Physics in South Africa, and this has been compiled by Profs Harm Moraal and Runan de Kok. The book was launched during the opening ceremony of the conference where we had the opportunity to pay tribute to all who contributed to the book. It is available in hard cover and soft cover for R500 and R250 respectively. As a membership benefit, it may be viewed online. The general public is able to view selected teaser material from the book. The SAIP website hosts a sub-site for the book, which solicits the “untold stories”, resulting from the era where not all South Africans were able to participate fully in physics. We trust we can all enjoy this excellent record of the more recent recorded development of our discipline, and that it will play a role in building our cohesion and coherent efforts to grow physics in our country.

Physics Comment

Physics Comment is a premier communication tool of the SAIP, and it is steadily developing in its profile. The editor is Prof Thomas Konrad, and he is assisted by the SAIP Executive office in the compilation and layout. We express our appreciation to them for their work. We are all urged to submit articles regularly.

International Partnership

The Institute continues to build on its partnerships with similar professional bodies elsewhere, such as the NSBP and the AIP in the US, the IOP in the UK, IUPAP, the AfPS and the AfAS. There are others, but those listed see regular activities and common programmes. We have several Memoranda of Understanding (MOU) with sister organisations. On the 8th of March 2013, the SAIP and the IoP renewed their relationship with the signing of a MoU on Joint Membership Services for SAIP and IOP members. At the same time, the SAIP and the IoP signed an additional MoU for their joint Physical Science Teacher Development project.

Financial and Legal

It is interesting to note the evolution of the SAIP from an organization whose capacity was based on a budget where the membership fees were a major component, to a budget where the membership fees are now a very small component. The grant and project income leverage these fees by more than a factor of twenty. This lead to a restructuring if the financial systems of the institute. This year this progressed to the level where the VAT status of the SAIP is now fully compliant. Within the context of a favourable VAT ruling for the SAIP, the Executive Office manages much of the operational financial affairs within the normal VAT vendor procedures. Prof Japie Engelbrecht has seen the Treasurer Portfolio grow to resemble the responsibilities and workload of a fully trained accountant in a large company. He retires this year and we are seeking his successor on Council. He has agreed to continue to serve as Treasurer until he can be replaced, which must happen before year end. This will also mark the transition to the appointment of a part time accountant, to assist the treasurer and the Executive Officer.

Concluding Remarks

Finally, I wish to thank the President Elect, Dr Igle Gledhill, (who assumes the role of President from tonight) and all members of Council for their service. We are a voluntary organization, and the portfolios of Council are becoming increasingly onerous, so this service is deeply appreciated. Special mention is also deserved by Dr Jackie Nel, who is the executive secretary of our Institute, and manages our documentation and institutional memory. Prof Japie Engelbrecht, one of the longest serving Council members, who has husbanded and nurtured the financial state of the SAIP with the deepest integrity and dedication, enabling the growth of the Institute, is attending his last SAIP Annual Conference as Treasurer. We also express our thanks for his service. Once again, I have to single out Mr Brian Masara and Mrs Linette White, who have run the Executive Office and enabled the SAIP to remain on its very positive upward growth trajectory. The role of the Division and Forum Chairs has expanded, with both the growth of the Institute and the implementation of the new Constitution. Special thanks to these Chairs, their committees and the members who give substance to the Institute through their voluntary work in service of our discipline. May our reward be the health of the discipline, and the continued growth of Physics in research, capacity building, innovation and in building the culture of a scholarly society.

Thank you very much.

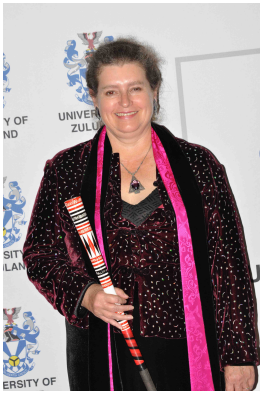
Simon Connell

President : SAIP Council

Zulu traditional weapon inspires Physicists at the 58th SAIP conference

by Prof Muzi Ndwandwe and Thulani Jili, University of Zululand

In the Zulu tradition the knobkerrie is one of the integral weapons of war. It symbolises strength and victory. When a Zulu warrior goes to war in defence of his beloved land, the King and Queen, his fellow countrymen and more especially his family, he would be entrusted with special weapons to unconditionally execute the command of the Generals. One of those weapons is the knobkerrie. If he survives the war and comes back in one piece, one of his weapons (which symbolizes human sacrifice and victory) would be kept in a sacred place at home. When he is old and realizes that he is about to die, he would convene a family meeting and appoint his elder son or his elder daughter to carry on the tradition and take over and keep this weapon which has now become a symbol of hard work and unity in the family. From now on this weapon will be passed on from generation to generation to inspire future warriors.



New SAIP President Dr Igle Gledhill with the knobkerrie

In the Physics community this tradition was first introduced in 2004 at Ithala Game Reserve during a weeklong 2004 Nuclear and Particle Physics Millenium School and for the first time in the history of the South African Institute of Physics (SAIP) it was introduced at the closing ceremony of the 2013 Annual Conference of the South African Institute of Physics which was hosted by University of Zululand. This beautifully crafted and decorated wooden stick, was handed over by the outgoing President of SAIP, Prof Simon Connell to the new SAIP President Prof Igle Gledhill. Chairperson of Local Organising Committee (LOC) of SAIP, Prof Muzi Ndwandwe assisted by Co-Chairperson Thulani Jili also handed another traditionally decorated stick to the incoming LOC Chairperson of the 2014 annual conference. This was the beginning of a tradition which will go down from SAIP President to future SAIP Presidents and from SAIP LOC Chairperson to future LOC SAIP Chairpersons. This is now a symbol of unity in SAIP tradition to inspire future scientists. One day when we are laid to rest, six feet underground, we would be happy of the sacrifices and strong foundation we laid in our lifetime for future scientists to prosper.

We are all inspired by this Zulu tradition.

Cochair Thulani Jili (left) holding the knobkerrie and Chairperson Prof Muzi Ndwandwe (right) together with SAIP President Simon Connell at the banquet.

Prof Muzi Ndandwe hands over the knobkerrie to the chairperson of the next Local Organising Committee, Prof Hartmut Winkler from the University of Johannesburg.

SACNASP, the Statuary Council for Physicists in South Africa

by Sarah van Arndt and Dr Rolf Becker, SACNASP, Pretoria

The South African Council for Natural Scientific Professions (SACNASP) is the statutory regulatory body for natural science practitioners. The Council is bound by the Natural Scientific Professions Act (Act 27 of 2003) which stipulates compulsory registration of all natural scientists.

To this end the overriding requirement is that even if a scientist belongs to an industry specific institute or learned society in order to practise, a natural scientist must be registered with SACNASP.

Why is this?

The main difference between a statutory body and an industry related institute is that membership of that institute is purely voluntary. By contrast, it is a legal requirement for a natural scientist to be registered with SACNASP. Therefore an unregistered natural scientist who is working in a natural science field is doing so illegally.

When scientists register with SACNASP they agree to a code of conduct. Failure to comply with this code of conduct constitutes improper behaviour. This protects the scientist, the profession and the consumer. If a scientist contravenes this code then the consumer has recourse to legal support from the Council. If a consumer wishes to take legal action against a registered scientist the Council can then, depending on the outcome, take action against the scientist. This can range from a fine to de-registration of the scientist – therefore preventing them from future work.

In addition to legal implications of registration SACNASP's other roles and responsibilities are defined within the Act. SACNASP further protects the profession by ensuring that educational standards are met. SACNASP has strong relationships with Council for Higher Education (CHE), South African Qualifications Authority and the tertiary institutions. Through these relationships SACNASP can:

- Set education and training standards
- Ensure that scientists meet the required educational standards
- Influence content material for tertiary courses

Because natural scientists cannot legally practise or consult in South Africa without being registered by SACNASP South Africa can uphold and promote the highest scientific standards and ethics; it not only allows South Africa to take its rightful place in the international scientific community, but also ensures that the work of our natural scientists is always professional and relevant.

Special Subject: Undergraduate Physics Education in SA

The Implications of the Review of Undergraduate Physics Education in S.A. for the benefit of broader society

by Dr Sam Ramaila -Chariperson: SAIP Council Education Committee (SAIP)

In the wake of the launch of the *Review of Undergraduate Physics Education in Public Higher Education Institutions Report* and the relevant accompanying wide media publicity, the process to holistically unpack its practical implications for social development of broader society becomes an inevitable and indispensable task. With the report now in the public domain, the physics community is cordially urged to engage with the report itself with a view to provide critical reflections that would meaningfully guide the implementation of the recommendations advanced. The implementation process should for all intents and purposes be a broad consultative, transparent and inclusive undertaking which makes provision for key stakeholder involvement.

In terms of the immediate key imperatives, the establishment of the Implementation Committee should be expedited as a matter of priority. One of the primary functions of the Implementation Committee would be the development of a cohesive and viable implementation plan underpinned by a sound fiscal implementation budget. In order to foreground the implementation process, monitoring and evaluation would subsequently be undertaken to critically assess the efficacy of the recommendations implemented. The preliminary implementation process design meeting involving the Group of Experts and the Planning Committee will be held in early October 2013 to provide the necessary key strategic focus and the appropriate requisite direction for the implementation process. The Group of Experts and the Planning Committee are constituted as follows:

Group of Experts

Prof Craig Comrie

Prof Rehana Vally

Prof Harm Moraal

Prof David Wolfe

Prof Makaiko Chithambo

Dr Mmantsae Diale

Dr Joseph Asante

Prof Ramon Lopez

Prof Carl Wieman

Planning Committee Members

Dr Sam Ramaila

Dr Igle Gledhill

Prof Tom Netshisaulu

Prof Simon Connell

Prof Azwinndini Muronga

Executive Office

Brian Masara

One of the key recommendations emanating from the report states: **"A four-year Physics undergraduate programme should be adopted".** While extended undergraduate programmes have largely been viewed as a panacea for student under-preparedness by several institutions in South Africa, there was a discontinuation of similar programmes at other institutions for mind-boggling and paradoxical reasons. Does this imply that there are institutions in South Africa vehemently opposed to the adoption and introduction of a four-year Physics

undergraduate programme? The pervasive reality is that it would be unreasonable to expect the overall quality of the basic education system to improve dramatically in the short to medium term. While the rollout of extended programmes was in full swing, there was a concomitant prevailing sentiment that it is imperative for these programmes to be defined in terms of clear structural parameters preferably as part of a nationally approved homogeneous four-year curriculum model applicable to all institutions and this resonates to a large degree with the key recommendation as stated.

Media coverage of the *Review of Undergraduate Physics Education in Public Higher Education Institutions Report* clearly highlighted the "sense of crisis" and it would not be prudent for the physics community to downplay this sentimental observation. A report by the Task Force on Teacher Education in Physics entitled *Transforming the Preparation of Physics Teachers: A Call to Action*, also vividly captures Physics Education deficiencies in the United States of America. Suffice to indicate that some of the key findings that emerged from the report include the following:

- Inadequate and inequitable science education is a threat to democracy.
- The state of high school physics affects the overall health of the physics profession.
- Mediocrity of physics performance by U.S. students compared to their international peers.

It is thus imperative that SAIP should not view its report in isolation. This also points to the fact that the Implementation Committee in partnership with various key stakeholders should ideally adopt a sophisticated evidence-based approach that would eventually engender meaningful monitoring and evaluation. As the custodian of the physics discipline, the physics community is expected to take the lead and play a pivotal role towards the realisation and meaningful achievement of the envisaged outcomes inspired by insatiable desire for fundamental change. To this end, the *Review of Undergraduate Physics Education in Public Higher Education Institutions Report* does in many ways provide the required intellectual space for robust engagement.

The Elephant in the Classroom

by Dr Igle Gledhill, SAIP President, Pretoria

The Crisis

There is concern, which has been identified as a crisis, in the physics community. I'd describe it, over the next few paragraphs, this way. We need well-qualified knowledgeable physicists. We need them in research; we need them in specialist domains, including those identified by DST: biosciences, nano-sciences, astronomy and space sciences. We need them in industry, and among the surprisingly large numbers of physicists who make their way into business or rocket science[1].

They are needed as excellent academic staff, doing remarkable research, and in the science councils improving the quality of life of South Africans. We also need them as numerate decision-makers and advisors.

We don't seem to have enough of them. This information comes through informally, for example from government sponsors of specialist domains ("we can get biologists and chemists, but not physicists"). There is some formal data [International Panel, 2004].

There is a complex system at work here, and I've ventured to put together a sketch, Fig. 1. I'm not an expert in education. This is a first-order picture of the system, but may be good enough for present practical purposes.

[1] The name often used for scientists in the financial sector

In the upper row are teachers (who also learn), and in the middle row are places of learning (and teaching). Underpinning these are the curricula, representing the extended part of the system, which I have not ventured to depict: Basic Education, Higher Education and Training, and Science and Technology, and their respective government Departments.

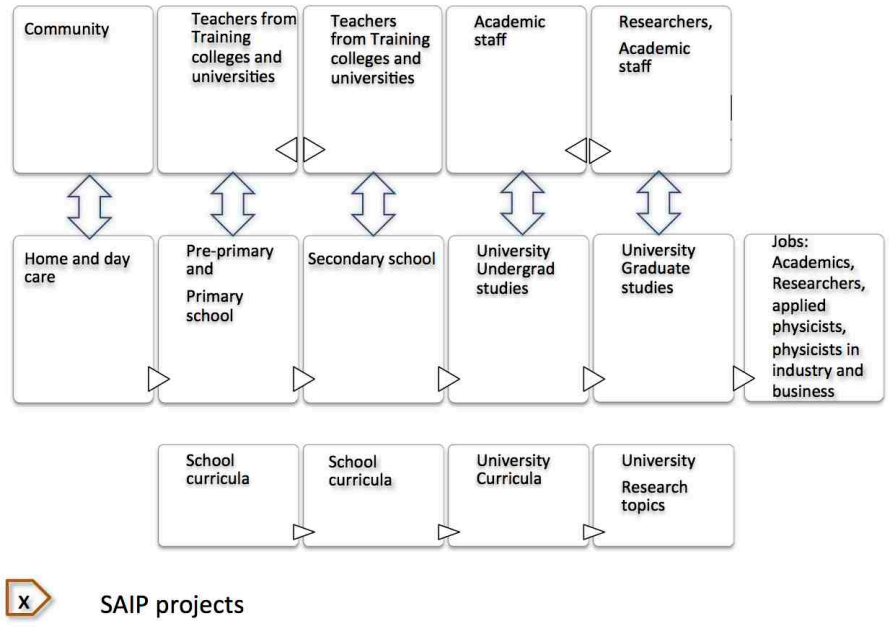


Figure 1: Education pipeline landscape as seen by a physicist

The problem described above is observed at the research end of the pipeline. Where does the problem come from? We hear, informally and formally, that many graduate students are registering without a good enough understanding of undergraduate physics, and part of the first year of the MSc may be spent putting in the groundwork of 3rd year and Honours. This problem shows up at the entrance point to undergraduate studies – and at every transition point through the studies.

The Heads of Departments, in their meetings at SAIP, identified a crisis in undergraduate teaching and learning. In response, the Physics Benchmark Curriculum [Zingu, 2012] was drawn up, and SAIP and CHE[2] performed phase 1 of a joint study (labelled U in the diagram) [CHE & SAIP, 2013]. There are recommendations from this physics-specific study, and CHE has recently released a study across all disciplines (Council on Higher Education, 2013) .

It is striking that *all* the University Physics departments in the Undergraduate study identified the quality of knowledge and skills among university entrants as unacceptably low. This does not mean that there are not excellent and willing undergraduate students; but the level of excellence at university entrance among students appears to be dropping, and the average capabilities are too low for the majority of students to cope within the 3 years of BSc studies with Physics as a Major. Where does this problem come from?

Secondary school education is widely discussed. Many people express opinions; many well-intentioned actions have been taken; but the challenges appear to be intensifying rather than being solved. The phenomenon is well-named as "the elephant in the classroom" [Chetty, 2013].

We could track the origins of the secondary school crisis back to the cognitive skills of leaners coming through from primary school and earlier systems, to the training and capabilities of teachers, and – as at all levels – to the underlying curriculum. The analysis here is brief and drawn up by physicists, not educationalists. For physicists, the fact remains that there is a problem here, and it cannot be ignored by our profession.

[2] The Council on Higher Education

What do we do?

Physicists have certainly engaged with these issues at multiple levels. The engagement has been personal, and through their departments and universities, through NGOs, and through government departments and agencies. SAIP has been taking action in practical projects; some, but not all, of these are mapped in the second sketch. At present, the most significant SAIP actions within the Education Pipeline are the provision of Teacher Training in partnership with the Institute of Physics, UK, and Phase 2, which is the implementation phase of the Undergraduate project. The Teacher Training programme, successfully piloted in June this year, has two aspects: hands-on maintenance and use of school lab equipment, and training, aided by the Virtual Physics Lab, in conceptualising and solving problems in the syllabus.

Co-ordination is one clear requirement. Engineers would call this Systems Engineering, and I suspect many physicists call it "thinking the problem through". SAIP can co-ordinate projects within its scope, with its sponsors, and with government.

There are uncounted projects throughout South Africa in the secondary school space. Many are successful, and excellent. They include kits, lab endowments, textbook and tablet endowments, tutors, mentors, expos, Science Centres, Exploratoria, open days, outings, Olympiads and prizes, School projects such as Dinaledi, and, not least, science clubs. One of the most valuable aspects is outreach: by physicists and astronomers, by National Facilities, companies and universities, and by NGOs[3]. The Council on Higher Education has "concluded that the overwhelming weight of evidence from current analyses of the school sector is that there is effectively no prospect that it will be able, in the foreseeable future, to produce the numbers of well-prepared matriculants that higher education requires", and proposes a solution within the Higher Education sphere [Council on Higher Education, 2013].

What are the biggest contributions SAIP can make? We are rigorous thinkers; we are active, professional scientists who recognise challenges in our community and engage with them. We can find the issues, test them, look for the supporting data, and test the consequences of proposals – and re-design until we have something not only viable, but something that works. The point of this article is to say: with each project, none of us wants our project portfolio to be boring, dull, or irrelevant. I suspect we each have a belief that physics is fun, funny, and fantastic, and we can't help putting that across with enthusiasm.

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[3] A note: The International Union of Pure and Applied Physics, IUPAP, *requires* outreach events to be included with conferences that it sponsors

Teacher Development Project – A flagship initiative of the SAIP

By Dr Sam Ramaila – Chairperson: Council Education Committee (SAIP)

In pursuit of socio-economic development and the need to provide impetus towards the realisation of the transformational impact of the Mathematics, Science and Technology Strategy in South Africa, the South African Institute of Physics (SAIP) in partnership with the Institute of Physics (UK) and the University of Johannesburg embarked on a Teacher Development Project that seeks to promote teacher professional development. Within the realm of teacher professional development, the project is largely viewed as a plausible quality-enhancing strategic flagship initiative geared towards the provision of essential training in various critical areas of need. Given the need to foster a coherent evolution of the project, the pilot phase is being implemented at the Soweto Campus of the University of Johannesburg as the identified delivery site. As key defining pillars of the project, training workshops were conducted in June 2013 with additional logistical funding support provided by the Department of Science and Technology. To a large measure, the project responds innovatively to the key ideals and recommendations encapsulated in the Review of Undergraduate Physics Education in Public Higher Education Institutions Report. Through their involvement in the project, teachers are particularly exposed to a Virtual Physical Laboratory (VPLab) which provides a meaningful platform for the simulation of physics demonstrations thus developing a coherent conceptual understanding of physics concepts. Inherent to the nature of the project is the need for a rigorous evaluation in order to closely monitor its impact as well as adherence to quality on an on-going basis in line with the key imperatives associated with its design and conceptualisation.

David introduces the program and discusses some 'virtual physics' with some of the teachers in training.

John demonstrates the effect of the number of turns on a transformer

Steve checks the paper-cup speaker/microphone before unleashing his 'magic' to the delight of the teachers.

Teachers find themselves engulfed in a vicious cycle of ever-changing curriculum reforms in South Africa and the need for professional development is paramount. Adding his voice to the implementation of the Teacher Development Project and other SAIP key strategic initiatives, former SAIP Council President, Prof Simon Connell, maintains that although we are a developing country, the last decade has seen dramatic improvements in the science system in South Africa coupled with an unprecedented improvement in the health of the discipline of physics which is on a new growth trajectory. Echoing sentiments in this regard, SAIP Council President, Dr Igle Gledhill, remarked that so many bright young South Africans aspire to reach greater heights in science and we need to put the right support for them in place.

Articles

South African scientists develop the world's first Digital Laser

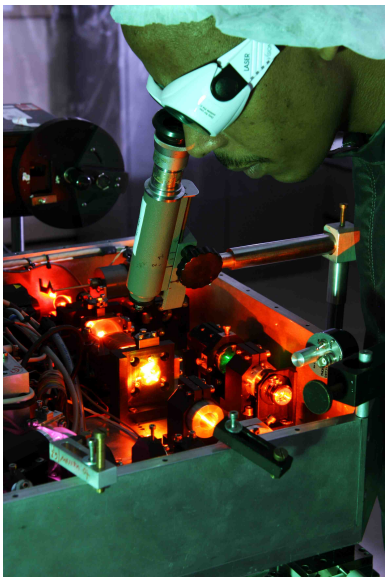
from Press Release of the CSIR, Pretoria

The invention of the world's first digital laser signifies a significant step forward in lasers and their applications. A team at the Council for Scientific and Industrial Research (CSIR) in South Africa has shown that lasers may be controlled with simple images so that customized laser beams are now only a picture away.

Researchers at the CSIR's National Laser Centre have developed the world's first "digital laser" allowing arbitrary laser beams to be created on the fly. The digital laser uses a liquid crystal display (LCD) as one of its mirrors, forming a digitally addressed holographic mirror. Just as with LCD televisions, so the LCD inside the laser can be sent digital images to display. When the picture changes on the LCD so the properties of the laser change accordingly. The team at the CSIR have shown that this allows digital control of what comes out of the laser (laser modes), in real time, so that customised laser modes may be selected on demand by changing only a picture written to the laser mirror. This world leading research has recently been published by the team (*Nature Communications* **4**, 2289 (2013)).

"This groundbreaking development is further evidence of the great potential we have in scientific innovation - that the world's first digital laser should come from our country is testimony to the calibre of scientists that South Africa has," says Minister of Science and Technology, Mr Derek Hanekom.

There is hardly a domain of our modern existence which does not benefit from some form of laser technology. The domains range from devices for laser lighting displays in entertainment to office equipment such as laser printers, DVD players at home, barcode scanners in the shops, surgical technology in hospitals or devices to cut and weld industrial materials in factories.



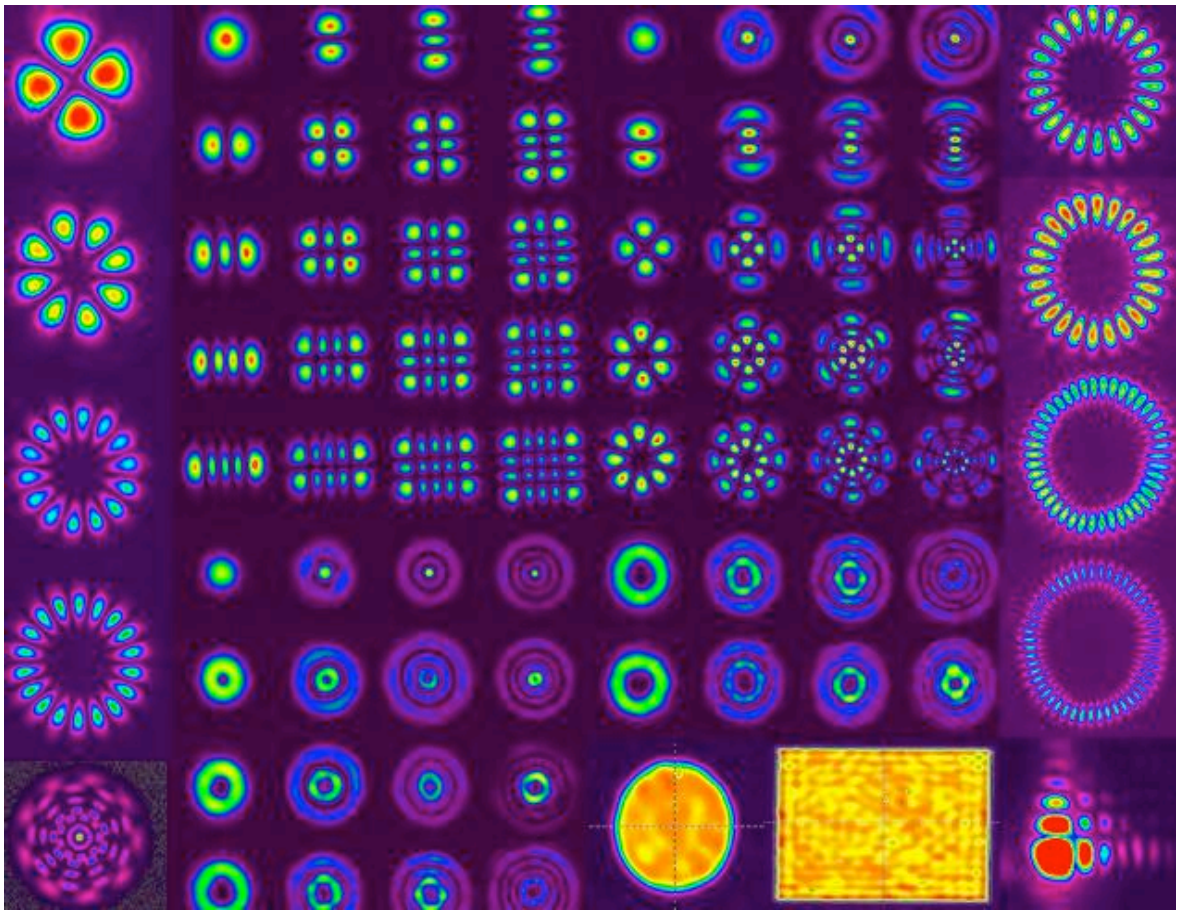
Sandile Ngcobo conducted the experimental work as part of his PhD

In conventional lasers the shape of the light that comes out is either not controlled at all, or a single shape is selected by expensive optics. Alternatively researchers would shape the laser light *after* exiting the laser using a spatial light modulator – a sort of LCD that can be digitally addressed with gray-scale images representing the desired change to the light. What the CSIR team have shown is that this can all be done *inside* the laser, where the LCD acts as the mirror at one end of the laser cavity. As the picture on the LCD is changed so is the laser beam that comes out of the laser. The laser beam is controlled in real-time in a purely digital manner, hence the name "digital laser". Not only did the team conceive of this idea, they actually demonstrated it in the laboratory, building the world's first such device. They showed that by sending an appropriate picture sent to the LCD, any desired laser beam could be created inside the laser. This is a significant advance over the traditional approaches to laser beam control which require costly optics and realignment of the laser for every beam change. Since this is all done with pictures, the digital laser represents a paradigm shift for laser resonators. Importantly, this technique only supposes knowledge of creating images and thus makes laser beam control accessible to a very wide audience.

In a landmark experiment to demonstrate the power of the digital laser, the group "played a video" inside a laser for the first time. In this ground breaking experiment the team programmed the LCD to play a video of a selection of images (like a movie on the internet) representing a variety of desired laser modes. The result was that the laser output changed in real-time from one mode shape to another. This dynamic control of laser modes could open up many future applications, from communications to medicine.

More information:

The work was done in the Mathematical Optics group at the CSIR's National Laser Centre. The team was led by Prof. Andrew Forbes, Chief Scientist and Research Group Leader, and supported by Post-Doctoral Fellow Dr Igor Litvin and Doctoral students Sandile Ngcobo and Liesl Burger. The lead student, Sandile Ngcobo, is registered at the University of KwaZulu-Natal as a PhD student where Prof. Andrew Forbes has an Honorary Professorship in the School of Physics and Chemistry.



Examples of the light modes created with the digital laser by only changing a picture written onto its mirror.

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THE QUANTUM POSSIBILITY OF AVIAN MAGNETORECEPTION

by Betony Adams, UKZN, Durban

How do birds do it?

There are few things that mark the turn of seasons as poignantly as the coming and going of birds; the swallows wheeling through the sky towing in their wake the first chill of winter. The Germans have a word for it, *Zugunruhe*, migratory restlessness. When experiments are done on birds confined to cages they hop and flutter their wings for the entire migration period, their bodies turned in the direction of their thwarted journeys [1]. But although it is a question that has fascinated man throughout history it is still not completely clear how birds, as well as other migratory creatures, effect these incredible journeys. A host of theories have been put forward including the fairly well established proposal that birds migrate using the earth's magnetic field. Just how they use this field is less clear. There are two dominant theories that address this question. One of these proposes the alignment of ferromagnetic crystals in the birds' beaks in a manner similar to how iron filings form patterns under the influence of a bar magnet [2]. Research suggests however that this system measures the intensity of the field rather than the birds' alignment in this field [3]. The other theory, which is being investigated at the University of KwaZulu-Natal and elsewhere [4,5,6,7], suggests that birds use quantum effects to align themselves through what is known as the radical pair mechanism.

The radical pair mechanism

In 1978 Klaus Schulten proposed a radical pair as the mechanism of magnetoreception [8]. A radical pair occurs when a photon transfers its energy to an atomic electron allowing it to move to a higher energy level and ultimately be donated to a neighbouring molecule. The result is an unpaired electron, or radical, in both donor and acceptor molecule. Together these electrons form the radical pair. Each electron has a quantum property known as spin. When the radical pair is created the spins of the two electrons are in a specific alignment with respect to each other, called a singlet state. Under the influence of the external magnetic field as well as the hyperfine interaction between each electron and its surrounding nuclei, this singlet state evolves into a different alignment of spins, a triplet state. Because this singlet to triplet conversion depends on the orientation in the magnetic field it offers a way of reading the field [9]. It is still not yet clear how the different spin states translate into a signal that the bird can interpret but it has been suggested that they form different chemical products, the relative amounts of which allow the bird to 'see' in which direction to fly. The biological molecule in which these reactions take place has been tentatively identified as cryptochrome, a flavoprotein which acts as a photoreceptor [3]. Cryptochromes are well understood in plants but the role of this molecule in migration is still uncertain. There are a number of questions that remain to be answered. What is the exact structure of the molecule and is it similar to the molecules that regulate circadian rhythms or repair faulty DNA? Why is avian magnetoreception so sensitive to specific wavelengths of light, allowing for perfect migration in blue and green light but disorientation in red?

Quantum possibility in living systems

Despite these unanswered questions the radical pair mechanism is well supported by experiments which indicate that avian magnetoreception is light dependent, gives results for weak fields [1] and is disrupted by an oscillating magnetic field [10]. What makes the mechanism of further interest is that it is part of a wider enquiry into quantum effects in biological systems. Conventionally, quantum systems are beyond the scale and temperature of biology and too isolated to be of use in the study of systems which must, as living things, interact with their environment. But using the theory of open

quantum systems, which offers a way of modelling the quantum system as well as its interaction with the environment, perhaps points the way to understanding the quantum possibility at the heart of life.

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Author Biography

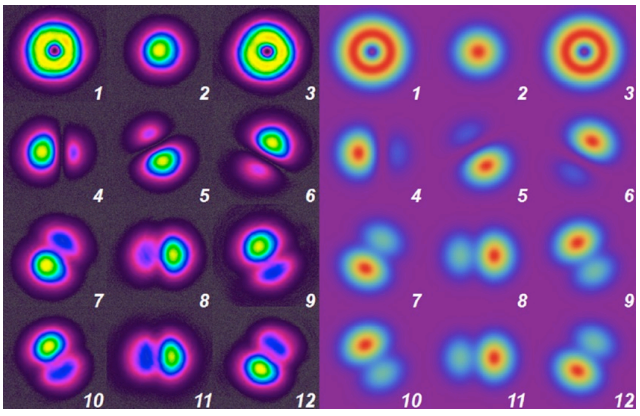
Betony Adams (betony@gmail.com) is an MSc student in the Centre for Quantum Technology based at the University of KwaZulu-Natal. Her thesis investigates the role of quantum effects in avian magnetoreception.

Digital Communication Just Got More Secure

by Prof Andrew Forbes, National Laser Centre, Pretoria

It has been known for some time now that high-dimensional entangled photons could be used for better security and higher information capacity of digital communication secured by quantum systems as information carriers. In this work [Phys. Rev. A 88, 032305 (2013)] researchers from South Africa, Canada and Scotland combined to realise this in the laboratory, using the twisted nature of photons to access quantum states in five dimensions for secure quantum key distribution (QKD).

Conventionally QKD is implemented with the polarisation states of light, allowing access to only two dimensions and thus limiting the information that can be packed into each photon, as well as the security of the QKD process. In contrast the spatial modes of photons allow access to many states, increasing the dimensions available for QKD. One such example is the twisted nature of light, its orbital angular momentum. Following on from their recent work on encoding higher-dimensional mutually unbiased bases (MUBs) from orbital angular momentum [Phys. Rev. Lett. 110, 143601 (2013)], the research team used holograms written to liquid crystal devices (spatial light modulators) to demonstrate an entanglement-based QKD protocol in five dimensions. MUBs offer security against eavesdropping, while the higher-dimensions led to an increase in information capacity and higher key generation rates per photon. These results suggest a way forward for faster and more secure communications systems using quantum communication.

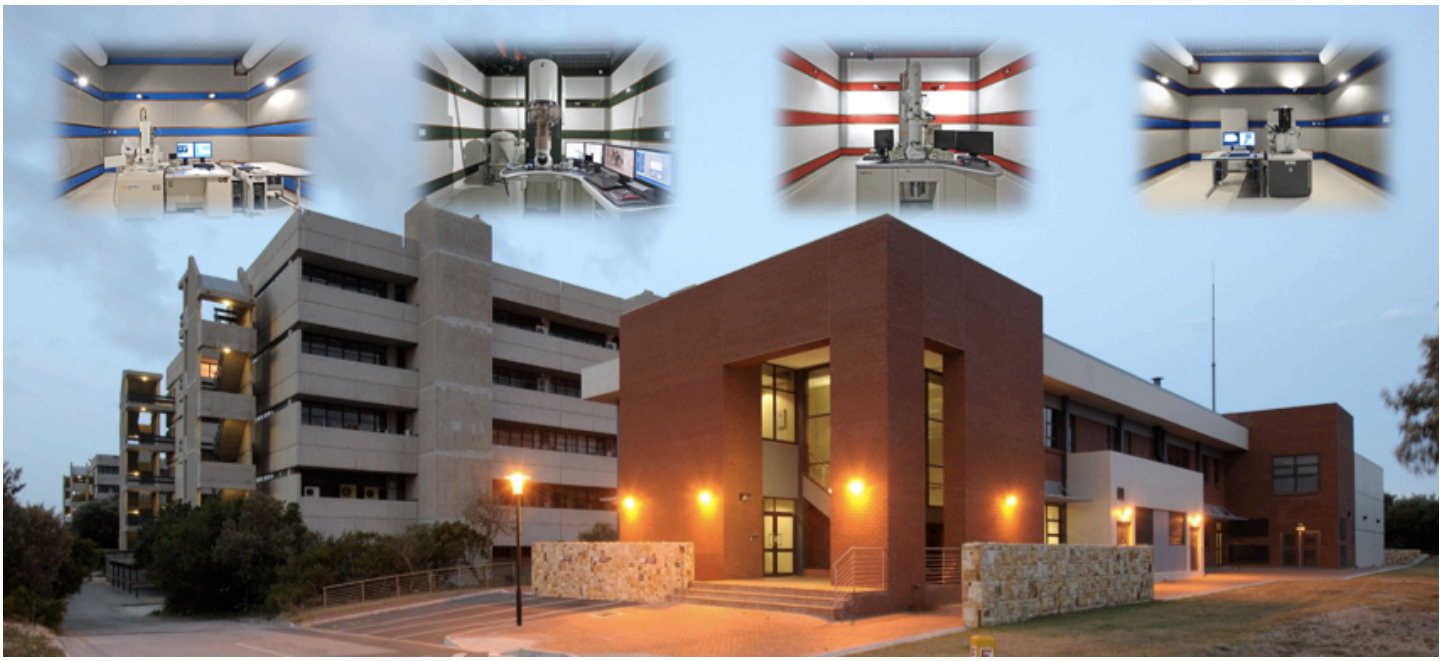


Intensity profiles of light modes that can carry information securely. On the single photon level only states belonging to the same basis (same row) can be distinguished from each other. Therefore information cannot be decoded without the knowledge of the basis (one of the four rows) in which it was encoded. The picture shows mutually unbiased bases of three dimensions in theory (on the right) and in the experiment (on the left).

Part of the international team from the NLC in Pretoria: Dr Angela Dudely and Prof Andrew Forbes.

Centre for HRTEM Provides Research Support for ESKOM

by Prof Jan Neethling, Nelson Mandela Metropolitan University, Port Elisabeth



Centre for High Resolution Transmission Electron Microscopy, Nelson Mandela Metropolitan University, Port Elizabeth. The Centre houses (top pictures from left to right) a JEOL 7001F FEG SEM, a JEOL JEM-ARM 200F double Cs corrected HRTEM, a JEOL 2100 LaB6 TEM, and a Helios NanoLab FIB-SEM

Centre for HRTEM at NMMU

In 1983 a committee of prominent South African scientists, representing the South African Institute of Physics and the Microscopy Society of Southern Africa, investigated the need for an advanced electron microscope facility in South Africa and identified a serious shortage in scientists skilled in the interpretation of advanced electron microscopy results. It was concluded that unless this problem was rectified, technological and academic developments in South Africa would be significantly hampered. Almost three decades later, on 11 October 2011, the first Centre for High Resolution Transmission Electron Microscopy (HRTEM) was launched at Nelson Mandela Metropolitan University (NMMU) in Port Elizabeth.

The establishment of the Centre was primarily funded by the Department of Science of Technology, through the National Research Foundation, under the guidelines of the National Research and Development Strategy which identified the need to create centres and networks of excellence in science and technology as a key component of human capital development and economic growth. Additional funding was obtained from the Department of Higher Education and Training, Sasol, the NMMU trust, THRIP and Dr Greg Olsen (GHO Ventures, USA).

The Centre houses a JEOL HRTEM and three other supporting state-of-the-art electron microscopes, as well as the complete enabling infrastructure for sample preparation and data processing. The gem of the Centre is the JEOL JEM-ARM 200F double aberration corrected HRTEM. With a resolution of 0.08 nm, the JEOL ARM can image and chemically analyse materials down to the atomic scale - a feat previously unattainable in South Africa. The Centre for HRTEM has become a leading global facility in materials characterization on the nano and atomic scale. It collaborates with research institutions across the world and in South Africa.

The significance of the nano and atomic scale electron microscopy research covers a wide range of key technologies – from identifying single iron atoms in graphene to obtaining information that could improve the safety of future nuclear reactors and extend the life of diamond drill bit inserts in oil drills. With the HRTEM it

was possible to solve problems that have been mysteries to international researchers for many decades, e.g. the release mechanism of radioactive silver in pebble bed type reactors, the phase of a specific platinum-silver alloy and the thermal degradation mechanism of diamond drill bit inserts. Atomic resolution imaging has also provided important new information on nanoparticle catalysts, platelets in natural diamond, steel exposed to high temperature and stress conditions in coal fired power plants and radiation damage in oxide dispersion strengthened steel and silicon carbide.

The Centre has already generated an impressive number of publications in a wide range of journals such as Nature Communications, Nano Letters, Journal of Nuclear Materials, Minerals Engineering and Nuclear Engineering and Design.

Research Support for ESKOM

As part of an Eskom programme to promote research activity and develop human resources, the Eskom Power Plant Engineering Institute (EPPEI) Materials Science Specialization group was established at the Centre for Materials Engineering (CME) at the University of Cape Town (UCT) at the beginning of 2012. The Centre for Materials Engineering at UCT then entered into a collaboration agreement with the Centre for HRTEM to participate in the Eskom Materials Science Specialisation programme in order to derive substantial support in advanced materials characterization of power plant materials using high resolution electron microscopy. The research focus is on the high temperature behaviour of engineering materials with emphasis on materials that are exposed to high temperature and high stress conditions in coal fired power plants. Two current projects focus on the microstructure and property assessment of creep aged stainless steel after welding and life assessment of turbine rotor steel.

On Thursday 18 July 2013, Mandela day for all South Africans, the quarterly feedback session of the EPPEI Material Science Specialisation group was held at the Centre for HRTEM. The session was attended by managers from Eskom, students, and academics from the CME, Stellenbosch University and the Centre for HRTEM. Although they could not give their 67 minutes of time directly on this day, the group worked towards a goal that will benefit all South Africans by providing affordable and reliable electricity and developing human capital as well as intellectual property for South Africa in South Africa.

Above: On Thursday 18 July 2013, the quarterly feedback session of the EPPEI Material Science Specialisation group was held at the Centre for HRTEM.

Author Biography: Jan Neethling is Professor in Physics at the Nelson Mandela Metropolitan University, and Director of the Centre for High Resolution Transmission Electron Microscopy. Prof Neethling has over 30 years' experience in the field of electron microscopy and materials science, and was the main driver for the establishment of the Centre for HRTEM. Email: jan.neethling@nmmu.ac.za

Opportunities

MSc & PhD Opportunities at UJ

The University of Johannesburg has positions for MSc and PhD studies in the following areas;

1) High Energy Physics (ATLAS Experiment)

2) Applied Nuclear Physics (Mineral-PET Diamond locator)

3) Materials Science (Diamond based gamma-ray undulator)

For more information and how to apply please contact Prof Simon H Connell shconnell@uj.ac.za phone +27 11 559-4380

Upcoming Conferences & Workshops

SAIP 2014 Annual Conference

The South African Institute of Physics Annual Conference for 2014 (SAIP 2014) will be held at the University of Johannesburg 7 to 11 July 2014.

Website:
http://indico.saip.org.za/event/saip2014

6th International Conference Hard Probes 2013 on Hard and Electromagnetic Probes of High-Energy Nuclear Collisions

By W A Horowitz and Heribert Weigert for the LOC

It is with great pleasure that we announce that the "6th International Conference on Hard and Electromagnetic Probes of High-Energy Nuclear Collisions (Hard Probes 2013)" will take place from Nov 4 to Nov 8, 2013 at the Stellenbosch Institute for Advanced Studies in Stellenbosch, South Africa, a delightful 30 minute drive into the wine country surrounding Cape Town.

We anticipate topics for the conference will include Jet quenching and observables; High transverse momentum light and heavy flavor hadrons; Initial state and proton-nucleus collision phenomena; Heavy flavor production and quarkonia; and Hard and thermal electroweak probes. A student summer school will be held prior to the conference.

We plan to construct a website, set registration dates, etc. soon. In the meantime, please mark your calendars, forward this notice to any potentially interested parties, and if you have any questions feel free to send them to this address, hp2013@tlabs.ac.za

School on Bayesian Analysis in Physics and Astronomy

HC Eggers, for the organising committee

Bayesian Analysis has grown strongly in the last decade as massive increases in data collection and computational power have opened up many opportunities and applications. Applications on which Bayesian Analysis can now be brought to bear include dealing with uncertainty in measurement, determining probabilities for questions not based on counting or relative frequencies, proper handling of small datasets, quantitative comparison between different models or hypotheses, and proper handling of nongaussian distributions.

The School on Bayesian Analysis in Physics and Astronomy will be taking place at the University of Stellenbosch and the National Institute for Theoretical Physics from **23 to 26 November 2013.** The School is aimed at both established **researchers in physics and astronomy** who regularly work with datasets and at **postgraduate students. No previous knowledge of Bayesian inference as such is required.** Participants should have some basic background in statistics as used in data analysis.

While the invited speakers have backgrounds in high energy physics and astrophysics, participants from all fields are welcome. This is a first announcement. For details and updates, see http://indico.tlabs.ac.za/conferenceDisplay.py?confId=42

Southern African Powder Diffraction Conference and Workshop

An interdisciplinary workshop organized by the South African Crystallographic Society in conjunction with the Powder Diffraction Commission of the International Union of Crystallography

27–31 January 2014

University of the Witwatersrand
Johannesburg, South Africa

Website : www.regonline.com/sapdfc

Powder diffraction, along with its affiliated techniques, have evolved greatly in recent decades. Its domain is no longer primarily limited to qualitative and quantitative analysis of mineralogical and industrial samples. Advances in instrumentation and the development of new methodologies have seen it increasingly used in studies that address contemporary scientific and socially important challenges. Notable research areas in which powder diffraction is used now include the study of energy and other functional materials, polymorphism, various catalytic systems and mechanistic details of phase changes, gas solid reactions and interactions, as well as nano-materials. Topics of interest within powder diffraction attracting significant interest include: structure determination, Rietveld refinement, non-ambient studies, reflectometry, small angle scattering, neutron based methods and electron crystallography, all important to materials science and nano-technology. Total scattering based methods have even extended the reach of powder diffraction to include short range order phenomena, such as those normally associated with amorphous or nano-materials.

The Southern African Powder Diffraction Conference and Workshop will be directed at solid state scientists from chemistry, biology, physics, materials science and related fields such as crystallography, spectroscopy, nano-technology and catalysis. The scientific sessions will include invited keynote and contributed oral presentations as well as poster sessions.

A limited number of IUCr-sponsored bursaries will be available for students and other young scientists, who are invited to apply for support with the recommendation of a supervisor or a senior colleague. Applicants can click the relevant button on the registration form (to be found on the conference website: www.regonline.com/sapdfc). Any support granted will be conditional on the acceptance of the abstract submitted by the applicant. Abstracts can be uploaded on the conference website. Early submission of abstracts is encouraged for those delegates seeking support.

Topics

Rietveld Refinement Structure Solution X-ray Diffraction Neutron Diffraction Non ambient studies Total Scattering (PDF) Reflectometry

Small Angle Scattering Magnetism Electron Crystallography

Confirmed Invited Speakers

Simon Billinge, Columbia University in the city of New York, USA
Bill David, ISIS Facility, Rutherford Appleton Laboratory; St Catherine's College, Oxford, UK Johan de Villiers, University of Pretoria, South Africa
Alain Gibaud, Université du Maine, France
Arnt Kern, Bruker AXS, Germany
Ute Kolb, Johannes Gutenberg-University, Mainz, Germany
Anatoliy Senyshyn, Technische Universität München, Germany
Axel Steuwer, Lund University, Sweden

Important Dates

Abstract submission deadline (orals & posters)	18 October 2013
Application for financial assistance	18 October 2013
Early Bird registration	31 October 2013

Organising committee

Dave Billing, (Wits, South Africa - Chair)
Ernst Ferg (NMMU)
Len Barbour (Stellenbosch University)
Andrew Venter (NECSA)
Daniel Wamwangi (Wits)
Habib Boughzala (University of Tunisia)
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The Organising Committee of SAPD2014 shall observe the basic policy of non-discrimination and affirms the right of scientists throughout the world to adhere or to associate with international scientific activity without restrictions based on nationality, race, colour, age, religion, political philosophy, ethnic origin, citizenship, language or sex, in accordance with the Statutes of the International Council of Scientific Unions. At this workshop no barriers will exist which would prevent the participation of bona fide scientists.

Physics Comment Editorial Policy

Deadline for submissions for the Dec. 2013 issue of Physics Comment is 30. November 2013

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/