SAIP

SOUTH AFRICAN INSTITUTE OF PHYSICS CONFERENCE

DATE: 08 - 12 JULY 2019

VENUE: THE RANCH HOTEL, POLOKWANE

SAIP

2019

64TH ANNUAL CONFERENCE OF THE SOUTH AFRICAN INSTITUTE OF PHYSICS

SOUTH AFRICAN INSTITUTE OF PHYSICS

University of Venda

Creating Future Leaders

SAIP

SOUTH AFRICAN INSTITUTE OF PHYSICS CONFERENCE

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ABBREVIATIONS

CERN	- European Organization for Nuclear Research
CSIR	- Council for Scientific and Industrial Research
DUT	- Durban University of Technology
FHIT	- Fort Hare Institute of Technology
HartRAO	- Hartebeesthoek Radio Astronomy Observation
LRI	- Laser Research Institute
NECSA	- Nuclear Energy Corporation of South Africa
NITheP	- National Institute for Theoretical Physics
NLC	- National Laser Centre
NMISA	- National Metrology Institute of South Africa
NMMU	- Nelson Mandela Metropolitan University
NWU	- North West University
RU	- Rhodes University
SAAO	- South African Astronomical Observatory
SANSA	- South African National Space Agency
SKA	- Square kilometre Array
SU	- Stellenbosch University
TUT	- Tshwane University of Technology
UCT	- University of Cape Town
UFH	- University of the Free State
UJ	- University of Johannesburg
UKZN	- University of KwaZulu-Natal
UL	- University of Limpopo
UNISA	- University of South Africa
UniVen	- University of Venda
UP	- University of Pretoria
UWC	- University of Western Cape
UNIZULU	- University of Zululand
WiPiSA	- Women in Physics in South Africa
WITS	- University of the Witwatersrand
WSU	- Walter Sisulu University

GENERAL INFORMATION

REGISTRATION DESK
The Registration Desk will be open from 07:30 daily throughout the conference. Registration will take place in WARRIORS/SAHARA foyer entrance.

WIFI
There is free WIFI for all delegates.
Details available at Registration Desk

WELCOME RECEPTION
Monday 8 July 17:00 – 19:00
Venue: WARRIORS/SAHARA
Bar arrangements: 2 Vouchers issued per person (can be found in the registration pack) you can get a beer or soft drink for your voucher.

TEACHERS WORKSHOP
Tuesday : 9 July 10:00 – 13:00
Wednesday : 10 July 10:00 – 13:00
Venue: MERLIN 2

POSTER SESSIONS
Tuesday 9 July 15:00 – 17:00
Thursday 11 July 15:00 – 17:00
Bar arrangements: 2 Vouchers issued per person (can be found in the registration pack) you can get a beer or soft drink for your voucher.

WOMEN IN PHYSICS LUCH
Wednesday 10 July 13:00 – 14:00
Venue: MAKHULU

PROJECT MONITORING AND EVALUATION WORKSHOP
Wednesday 10 July to Thursday 12 July
Venue: GARDEN ROOM

TOWN HALL / PUBLIC MEETING
Wednesday 10 July 16:00 – 18:00
Topic: National Institute for Theoretical and Computational Sciences (NITheCS)
Venue: BACCHUS

PHYSICS BOWL
Wednesday 10 July 17:00 – 18:00
Venue: MAKHULU

PHYSICS IN INDUSTRY DAY
Friday 12 July 10:00 – 13:00
Venue: DAYLILLY

PLENARY WITH DEPARMENT OF SCIENCE AND TECHNOLOGY (DST)
Friday 12 July 10: 00 – 13:00
Venue: MAKHULE

GALA DINNER
Friday 12 July 18:00 – 21:00
Venue: SAHARA
Bar arrangements: 2 Vouchers issued per person (can be found in the registration pack) you can get a beer or soft drink for your voucher.

EMERGENCY NUMBERS
SAPS Polokwane :
015-290 6531
Netcare Hospital Polokwane :
015 296 6500
Polokwane Hospital :
015 287 5000
The Ranch Hotel Reception :
015 290 5000

ORGANISING COMMITTEE

- **NE MALUTA**
  Chairperson
- **IP MATAMBA**
  Deputy Chair
- **V KHOMUNALA**
  Coordinator of Secretariat
  (015 962-8162)
- **TS MULAUDZI, P NEMAANGANI, W MABONGO, V NEKHUBVI**
  Dinner / Opening / Social Events
- **D TINARWO, J KIRUI, TS RAVHENGANI**
  Fundraising
- **TT KHEDZI, V NEKHUBVI, L JHAMBA**
  Student Affairs / Student Housing
- **F NEMANGWELE, TS MULAUDZI**
  Scientific Program
- **NETSHAULU J, TT KHEDZI**
  IT, WIFI, Network
- **RS DIMA, K MASHAVHATHAKA**
  Posters
- **W MABOGO, M MASISI**
  Conference Branding / Publicity
- **D TINARWO, RS DIMA**
  Physics Bowl
- **TS RAVHENGANI, JK KIRUI**
  Teacher's Events
- **K MASHAVHATHAKA, JK KIRUI, RS DIMA**
  Winter Schools

GUIDELINES

GUIDELINES FOR SPEAKERS

- Slots of length 20 minutes have been allocated for orals: 15 minutes for presentations and 5 minutes for questions.
- It is important to double check the date, time and venue for your presentation.
- Technicians will be available in each room to assist speakers on uploading their presentations. Please do this well before your session, such as the day before. Inform the technician if your presentation has sound or video clips.
- Be on time and report to the chair.
- Is your talk part of a group presentation? Are you a student completing for one of the prizes?
- You are not permitted to move your presentation to any other slot.
- Please respect the time-keeping of the chair.

GUIDELINES FOR SESSION CHAIRS

- Please keep to the scheduled times.
- Re-check the date, time and venue of your session.
- Please be on time, at least 5 minutes before your session starts.
- Consult with the session assistant in the venue (whether presentations are on computer and how the microphone system works).
- Identify the speakers before your session starts.
- No alterations are to be made to the programme.
- Talks may not be moved earlier due to a speaker not turning up.
- Welcome delegates and speakers at the beginning of your session.
- Make the following announcements:
  - All cell phones are to be switched off
  - The title and name of the speaker
  - Whether it is a group presentation.
  - Whether the speaker is competing for an MSc or PhD prize.
- Allow questions according to time. Stay within the time slots.
- Thank all the speakers at the end of the session.
- Report problems to the session assistant.

POSTERS

- Posters should be displayed on the allocated board for the duration of the conference.
- Board assignments will be according to contribution number.
- Must be available at your poster during the assigned poster session.
- Judging for student prizes will occur during the assigned poster sessions only.

ACCOMODATION

THE RANCH PROTEA HOTEL
reservations@theranch.co.za
+27 (0) 15 290 5000

TIVEKA GAME LODGE POLOKWANE
reservations@tiveka.co.za
+27 (0)15 291 5004
7.5km via R101 to the ranch
33.5km via R101 to town

DINOKO LODGE POLOKWANE
info@dinokolodge.co.za
+27 (0)15 225 7073 / +27 (0)72 222 3443
20.0km via R101 to the ranch
22.3km via N1 to the ranch

MEROPA TOWN LODGE POLOKWANE
tlpolok.resv@clhg.com
+27 (0)15 292 4400
19.5km via R101 to the ranch
24.6km via N1 to the ranch

GARDEN COURT POLOKWANE
www.tsogosun.com
+27 (0)15 291 2030
23.7km via R101 to the ranch
31.1km via Kerk to the ranch

ESKULAAP HOTEL POLOKWANE
admin@eskulaap.co.za
+27 (0)15 297 3288
26.7km via R101 to the ranch
28.8km via N1 to the ranch

PARK INN POLOKWANE
www.parkinn.com
+ 27 (0)15 495 0969
26.0km via R101 to the ranch
44.0km via Biccard street to town

PROTEA HOTEL POLOKWANE
www.marriott.com
+27 (0)15 225 8100
24km to the ranch
10km to city centre.

EXHIBITORS & SPONSORS

- UNIVERSITY OF VENDA
- LIMPOPO TOURISM DEPARTMENT
- OPTICAL SOCIETY OF AMERICA
- BLUE STALLION TECHNOLOGIES CC
- PERT INDUSTRIALS (PTY) LTD
- NELSON MANDELA UNIVERSITY
- STELLENBOSCH UNIVERSITY
- THE CENTRE FOR HRTEM (NELSON MANDELA UNIVERSITY)
- SQUARE KILOMETRE ARRAY (SKA SA)
- SOUTH AFRICAN COUNCIL FOR NATURAL & SCIENTIFIC PROFESSIONS (SACNSP)
- CENTRE FOR SPACE RESEARCH (NORTH WEST UNIVERSITY)
- NATIONAL ASTROPHYSICS AND SPACE SCIENCE PROGRAMME (NASSP) (UKZN)
- CB VAN WYK FAMILY TRUST (UNIVERSITY OF THE FREE STATE)

OSA® The Optical Society | 100 Since 1916

Sponsor for the Photonics division student prize.

University of Venda
Creating Future Leaders

VENUE INFORMAITON

IN-ROOM FACILITIES

- FREE WiFi — 500MB PER DAY
- EXECUTIVE WORK DESK
- AIR CONDITIONED
- ELECTRONIC SAFE
- LCD FLAT SCREEN & DSTV
- HAIRDRYER
- TEA & COFFEE MAKING-FACILITIES
- MINIBAR FRIDGE

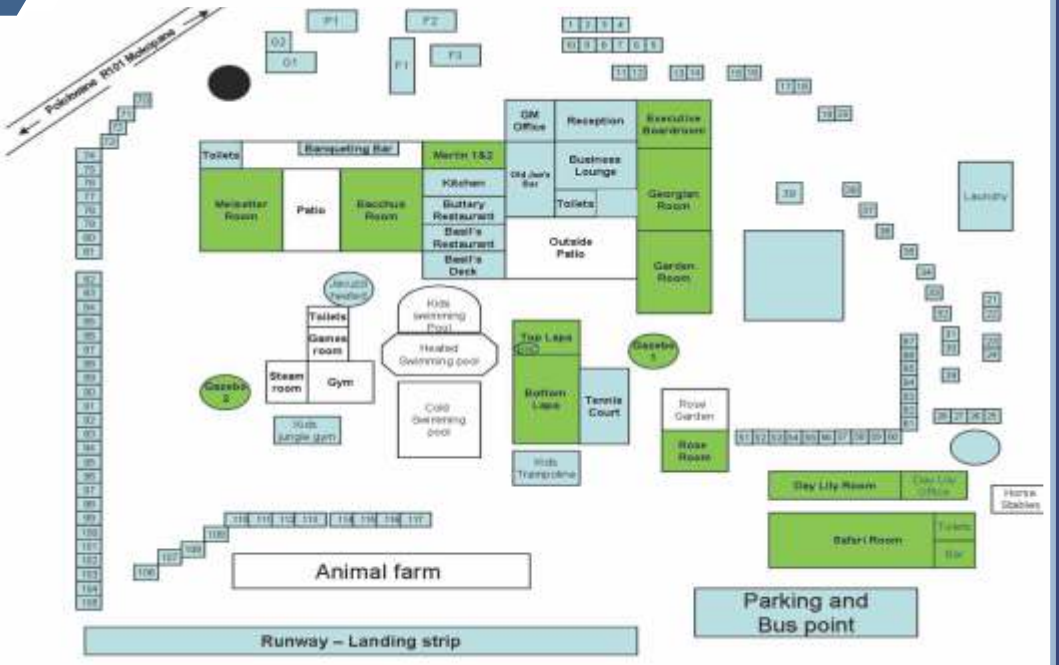
DISTANCE FROM HOTEL

30 KM	POLOKWANE INTERNATIONAL AIRPORT
222 KM	GOBLERSBRUG BOTSWANA BORDER
233 KM	KRUGER NATIONAL PARK
245 KM	ZIMBABWE BEIT BRIDGE BORDER
280 KM	O.R. TAMBO INTERNATIONAL AIRPORT

FOOD & BEVERAGE SERVICE TIMES

BREAKFAST	06H30 – 10H00
LIGHT LUNCH	12H00 – 18H00
À LA CARTE DINNER	18H00 – 22H00
ROOM SERVICE	10H00 – 22H00
COFFEE BAR	06H30 – 22H00

VENUE MAP AND LAYOUT



PROTEA HOTEL®

Polokwane Ranch Resort

Farm Hollandsdrift,
25 km South of Polokwane,
on N1/R101, Limpopo 0699,
South Africa
Tel: +27 (0) 15 290 5000
Fax: +27 (0) 15 290 5050
Email: reservations@theranch.co.za
GPS: 24° 2'38.47"S - 29°16'25.20"E

Physics

The **Department of Physics at Stellenbosch University** has a proud history, producing outstanding research and many excellent graduates since 1903.

Our graduates are well-rounded physicists with the technical and specific scientific skills required to make a unique contribution to the research and development environment.

THEORETICAL PHYSICS

Our research activities focus on quantum field theory, quantum mechanics, statistical and computational physics with applications to condensed matter theory, high energy physics, Bayesian physics, biophysics, and other complex many-body systems.

Members also work in collaboration with the National Institute for Theoretical Physics and numerous international partners.

Learn more about our theoretical physics environment at

http://www.physics.sun.ac.za/theory

LASER PHYSICS

In the Laser Research Institute we use lasers in innovative ways for quantum control of atoms, quantum nanophotonics, studying of ultra-fast processes, novel microscopy techniques, probing inside cells and crystals and developing custom lasers.

Our staff and vibrant group of postgrads have well-equipped photonics laboratories. We collaborate productively with South-African and international partners and the CSIR National Laser Centre.

Learn more about the Laser Research Institute at

http://www.laser-research.co.za

NUCLEAR PHYSICS

We have expertise of international standard in experimental and theoretical nuclear physics as well as applied nuclear physics, radiation and health physics.

We are closely aligned with iThemba LABS, which provide the facilities for basic and applied research using particle beams, particle radiotherapy for the treatment of cancer and the supply of accelerator-produced radioactive isotopes for nuclear medicine and research.

Learn more about the Nuclear Physics research group at

http://www.physics.sun.ac.za/nuclear/

Contact us: Department of Physics
Tel 021 808 3391 | E-mail physoffice@sun.ac.za
http://www.sun.ac.za/english/faculty/science/physics

S 100 1918 · 2018

SCIENCE
NATUURWETENSKAPPE
EYOBUNZULULWAZI

WELCOME MESSAGE

PRESIDENT OF THE SOUTH AFRICAN INSTITUTE OF PHYSICS

It is my pleasure to welcome you all to the 64th annual conference of the South African Institute of Physics (SAIP), hosted by the department of Physics at the University of Venda. The conference takes place from 8-12 July 2019 at the Protea Ranch Hotel in Polokwane. I would like to extend a warm welcome to all of you and in particular to the students who attend the annual conference for the first time. The organisers have put together a very exciting program this week, starting with a winter school on 'Condensed Matter and Renewable Energy Materials' on Monday 8 July, followed by four days of presentations in each of the divisions and forums of the SAIP, including the invited plenary talks by world-renowned specialists in their respective fields of physics.

I am particularly pleased to welcome our invited plenary lecturers to Polokwane. A warm welcome to Prof Regina Maphanga, Prof Alison Walker, Prof Kate Shaw, Prof Patricia Doherty, Prof Eric Mazur, Prof Stephan Woodborne, and the SAIP 2018 Gold Medallist, Prof Patricia Whitelock. Prof Whitelock will be presented with the SAIP 2018 Gold Medal after her plenary lecture.

I congratulate the organising committee for bringing together such a wonderful and inclusive selection of world-renowned physicists to the annual conference. To the invited plenary lectures, I thank you for joining our vibrant community this week, and sharing your scientific expertise with the students and emerging researchers. I encourage all, especially the students, to engage in discussions with the invited plenary lecturers.

After the success of the Physics in Industry Day hosted by the Applied Physics Division at the 63 rd annual conference of the SAIP in 2018, there is again a special session in the conference program this year for a Physics in Industry Day, on Friday 12 July. Another recurring feature on the SAIP annual conference program is the annual Physics Bowl competition which is scheduled for Wednesday 10 July. This is already the 4 th edition of the Physics Bowl. Get ready for lots of physics fun and excitement.

The conference will also host a number of workshops. On 9 - 10 July, there is a Teacher Development workshop for around 50 teachers from the Vhembe district of the Limpopo province. This is part of the SAIP's very successful and important teacher development program. Another workshop that will run this week (10-11 July) is a Monitoring and Evaluation workshop, where representatives from the Institute of Physics (IOP, UK) and the Tanzanian Physical Society will meet with the SAIP to discuss how best to monitor and demonstrate impact of projects run by the institute, as well as discuss opportunities for cooperative projects. I'm delighted to welcome colleagues from the Department of Higher Education and Science and Technology who will present highlights and updates of ongoing initiatives supported by DST in Astronomy and Physics. This includes a panel discussion and a Q&A session and is scheduled for Friday 12 July.

Diversity, gender equality and inclusivity are key elements of our institutional culture. The Women in Physics in South Africa (WiPiSA) have invited Prof Kate Shaw to deliver the WiPiSA plenary lecture on Wednesday 10 July, entitled “Physics for all: Rebuilding our community for everyone”. The WiPiSA lunch is scheduled on the same day. I note with great appreciation and enthusiasm that the organising committee excelled in achieving diversity, gender equality and inclusivity in their list of invited distinguished plenary speakers; five out of the seven speakers are women physicists.

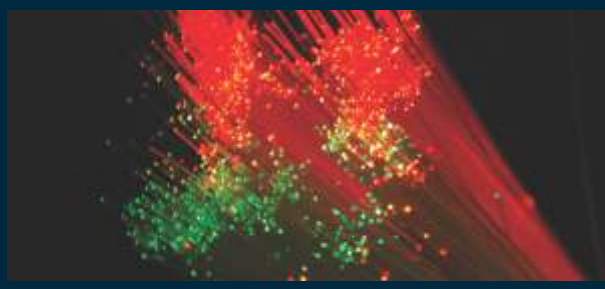
I invite all members of the South African Institute of Physics to attend the Annual General Meeting (AGM) on the final day of the conference, which is followed by the Gala Dinner that same evening. To all the students, particularly those of you who attend the SAIP annual conference for the first time, I would like to say that the SAIP annual conference is a place to present your work to colleagues, to meet our community of physicists across a broad range of disciplines, and to make new friendships and networks that can last a professional life time. Make the most of all the opportunities this week, this is your conference.

In concluding, I want to express my sincere gratitude to the organisers of SAIP2019 - the colleagues of the Department of Physics at the University of Venda, led by Dr Eric Maluta - for putting together a very exciting program, showcasing the very best of South African research in physics and physics education, and for bringing the South African physics community to the heart of the Limpopo province.

I wish you all a very successful conference!

PROFESSOR PATRICK WOUDT
PRESIDENT : SOUTH AFRICAN INSTITUTE OF PHYSICS

NELSON MANDELA
UNIVERSITY



Department of **Physics**

Photovoltaics

Sustainable Energy for the Future

The Photovoltaics Research Group focusses on the characterisation of Photovoltaics (PV) materials, devices and systems. The facilities include:

- Photovoltaic Research Laboratory (PV Lab) for advance solar cell and PV module characterisation
- Outdoor Research Facility (ORF) for PV module and system monitoring and characterisation
- ISO17025 accredited Photovoltaic Test Laboratory (PVTL) – PVinsight (Pty) Ltd

The following Applied Physics skills are also acquired:

- Advance solar cell and PV module characterisation and evaluation
- Data acquisition an analysis, including curve fitting and parameter optimisation
- LabView programming and computer interfacing
- Data acquisition system design

For further information on student projects please contact the PVRG.

Prof Ernest van Dyk
E ernest.vandyk@mandela.ac.za

Optical Fibre Telecommunication Research

Escalating bandwidth demands fuelled by smartphones, tablet computers, social media and cloud computing makes Telecommunications an extremely challenging and rewarding field.

Nelson Mandela University has one of the best equipped Optical Fibre Research laboratories in Africa.

We offer an exciting range of MSc and PhD projects featuring:

- Dispersion measurement, compensation and emulation
- Fibre-to-the-home (FTTH) technologies
- Square Kilometer Array related optical fibre topics
- Polarization effects, wavelength division multiplexing, non-linear effects
- Modelling and simulation, OTDR, fusion splicing, bit error rate testing

The Optical Fibre Research Unit is part of the Telkom-sponsored Centre of Excellence.

Scholarship opportunities are available for good, motivated students.

Prof Tim Gibbon
E tim.gibbon@mandela.ac.za

WELCOME MESSAGE

VICE CHANCELLOR AND PRINCIPAL

The University of Venda management warmly welcome you to the 64 th South Africa institute of Physics conference, SAIP 2019.

As vice Chancellor and Principal it gives me great pleasure to welcome all conference delegates to the SAIP 2019 conference, which is held by the Department of Physics, University of Venda at the Ranch Protea Hotel, Polokwane, South Africa. We are excited to have the opportunity to host the 64 the annual conference of the South Africa institute of Physics, particular in the year where the world is celebrating the periodic table as an International Year of the Periodic Table of Chemical Elements.

We welcome all Physicists and postgraduate student from all South Africa universities, Africa and the international world. We hope you will exchange all the research findings, ideas, meet with old friends and make new friends. The department of physics at the University of Venda is always taken as the pool of physics student graduate who always go further with their physics studies in other institution.

But currently the department has started to work hard on the Renewable energy research and has started to produce better masters and PhD students I hope you will not only learn the physics around the hotel over the whole week, but you will also take this opportunity to visit the northern part of South Africa and take trip to visit Venda area which is a piece of Eden of Africa. The land has all fruits, vegetables and the culture is of interest to see.

It is place to visit and see the wild animals and especially the Big Five in the Kruger national park, Mapungubwe, etc.
I wish you a successful week of exchanging physics novel ideas.

DR. B NTHAMBELENI
VICE CHANCELLOR AND PRINCIPAL
UNIVERSITY OF VENDA

HOD OF PHYSICS / CHAIR OF LOCAL ORGANIZING COMMITTEE SAIP 2019

I am pleased to welcome you to the 64 th South Africa Institute of Physics Annual Conference on behalf of the Department of Physics of the University of Venda. The department is overwhelmed to be the host of the 64 th SAIP 2019 annual conference. It is now a history in the department of physics to host the SAIP conference.

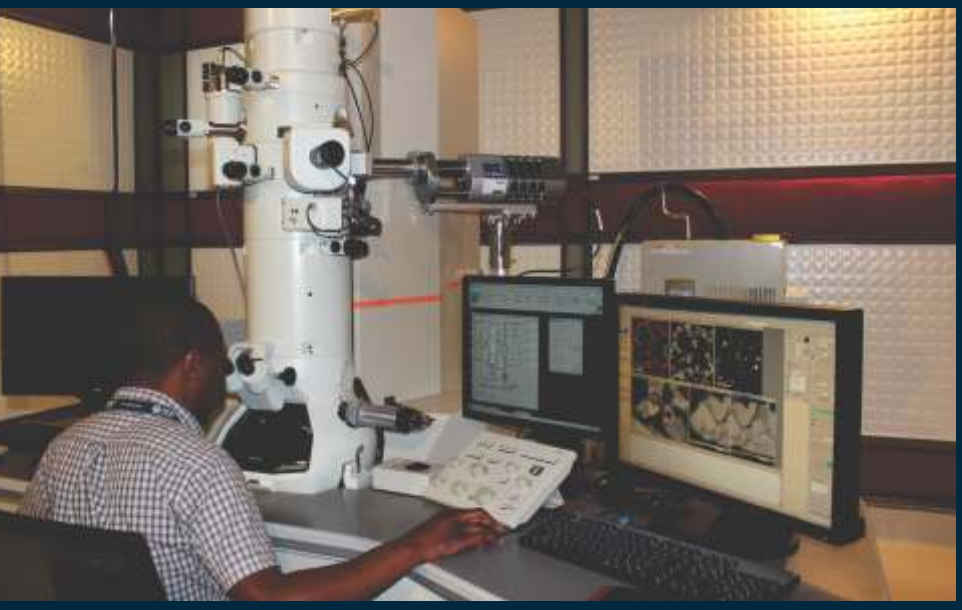
To our knowledge this is the first time for the department to host this annual conference. It has been a journey for the department to organize this important event. Due to circumstances beyond our control we have chosen the Ranch Protea Hotel to be our venue for the conference.

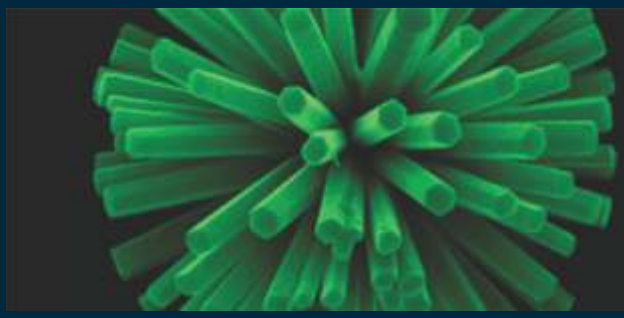
We will be show chasing different cultural activities during the conference. The department of physics focuses on computational physics, atmospheric physics, renewable energy and energy materials, which we hope all this will play a role in the future progress of human kind.

As the current head of department of Physics, I would like to thank all participants, sponsors and LOC committee to make this event to happen. Specifically I would like to appreciate the plenary speakers, and delegates for their contribution of enriching this conference through their presentation and discussion.

This is one of the conference where 90% of the plenary speakers are women. I hope all delegates will enjoy the conference, make new friends, discuss ideas and get new ideas and enjoy Limpopo part of South Africa. This is the home of the Big Five, please feel free to visits different national parks in the Limpopo Province.

NELSON MANDELA
UNIVERSITY





Department of **Physics**

Electron Microscopy for Materials Research

The Centre for High Resolution Transmission Electron Microscopy (Centre for HRTEM) at Nelson Mandela University houses four state-of-the-art electron microscopes including the only aberration-corrected atomic resolution electron microscope in Africa. The wide range of research projects and MSc and PhD topics include:

- HRTEM and in situ HRTEM investigation of nanoparticle catalysts
- Irradiation damage and fission product transport in nuclear reactor materials
- Corrosion resistant nuclear reactor materials
- Refining of weldability limits of creep-aged power plant stainless steel
- Lifetime assessment of high value power plant components
- Characterisation of diamond, Pt, Ti and Al alloys, compound semiconductor structures and gold and platinum bearing ores

Prof Jan Neethling
E jan.neethling@mandela.ac.za

Semiconductor Materials Development

This research focuses on vapour phase and solution-based deposition of semiconductors for opto-electronic devices.

The Physics Department has unique equipment for the synthesis and characterization of semiconductor thin films and nano-structures, including a state-of-the-art reactor for compound semiconductor deposition.

We currently develop:

- Epitaxial InAsSb and related compounds for infrared detectors
- ZnO nanorods for high efficiency white LEDs and hybrid solar cells
- Nanostructured TiO2 for solar water splitting

Our active collaborations with several local and overseas universities over many years, including groups in Sweden, Germany and the UK, have forged excellent academic links.

For information on these exciting research topics contact:

Prof Reinhardt Botha
E reinhardt.botha@mandela.ac.za

WELCOME MESSAGE

DEAN SCHOOL OF MATHEMATICAL AND NATURAL SCIENCES

It is my privilege to welcome you to the 64th Annual Conference of the South African Institute of Physics (SAIP) 2019 in the Vhembe District of the Limpopo Province.

The School of Mathematical and Natural Sciences is proud of the Physics Department and is supporting the Departmental staff in hosting this years delegates to not only discuss new research and other advances in the field and allow established scientists a great opportunity to showcase their research, but also mentor young and emerging scientists.

As a School we are also proud of the Vuwani Science Research Centre which is serving the surrounding communities and schools with various projects in which Physics plays a central role. The coordinator of the Vuwani Science Research Centre is the HOD of the Physics Department.

I believe this Conference will bring many new opportunities to make friends, establish new collaborations and learn more from each other. I sincerely wish all participants a memorable experience.

PROF NATASHA POTGIETER
DEAN SCHOOL OF MATHEMATICAL AND NATURAL SCIENCES
UNIVERSITY OF VENDA

DEPUTY VICE-CHANCELLOR ACADEMIC

It is a great honour to welcome all the delegates to the 64th Annual Conference of the South African Institute of Physics (SAIP) 2019. The University of Venda's Department of Physics (School of Mathematical and Natural Sciences) will host this prestigious event at the Ranch Protea Hotel Polokwane, during the week of 08 - 14 July 2019. We are excited to welcome delegates from all the different fields of Physics; from South Africa, from the rest of the Continent of Africa, and from the rest of the world.

Our Department of Physics focusses on renewable energy research as a departmental and institutional nice research area. This focus is particularly relevant in a world increasingly concerned about the manifestations of global climate change, driven by the prevailing carbon economy. Physics, as a fundamental scientific discipline concerned with the natural properties of matter and energy, will play a major role in the future progress of humankind, as it underlies all technological advancement.

The Department of Physics at the University of Venda is the envy of many academic physicists at other institutions who are saddled with service courses for the applied sciences. The absence, until now, of an engineering faculty at our institution had the unintended but advantageous consequence that the Department has been free to concentrate on the teaching of theoretical physics, and we are proud of the many physics graduates from our university who excel in this field.

We are proud to have some of our staff members from the Department of Physics as members of the South African Institute of Physics, participating, with their students, in its annual conferences A discipline-based conference like the SAIP creates an opportunity for global collaborative networks to be formed, for research ideas and findings to be exchanged, and for networks between postgraduate students, delegates and invited speakers to be established. I would like to thank all the participants for enriching this conference through their presentations and discussions, and I wish you all a memorable conference.

PROFESSOR JAN ERNST CRAFFORD
DEPUTY VICE-CHANCELLOR ACADEMIC
UNIVERSITY OF VENDA

NELSON MANDELA
UNIVERSITY

Centre for High Resolution Transmission Electron Microscopy

Electron Microscopy for Materials Research

The Centre for High Resolution Transmission Electron Microscopy at the Nelson Mandela University houses four state-of-the-art electron microscopes including the only aberration-corrected atomic resolution electron microscope in Africa. The wide range of research projects and MSc and PhD topics include:

- HRTEM and in situ HRTEM investigation of nanoparticle catalysts
- Irradiation damage and fission product transport in nuclear reactor materials
- Corrosion resistant nuclear reactor materials
- Refining of weldability limits of creep aged power plant stainless steel
- Lifetime assessment of high value power plant components
- Characterisation of diamond, Ti and Al alloys, compound semiconductor structures and gold and platinum bearing ores

For more information on available postgraduate and postdoctoral research topics, or to request access to our facilities, please visit our website: chrtem.mandela.ac.za

Centre.HRTEM Centrefor_hrtem Centrefor_hrtem

PATRICIA H. DOHERTY, DIRECTOR & SENIOR SCIENTIST INSTITUTE FOR SCIENTIFIC RESEARCH BOSTON COLLEGE USA

BIOGRAPHY

Patricia H. Doherty is the Director and a Senior Scientist of the Institute for Scientific Research (ISR) at Boston College (BC). As director of the Institute, she oversees the activities of staff members working on a variety of innovative research projects. These projects include studies of space physics, space weather, ionospheric and atmospheric effects on space-based systems, ionospheric measurement techniques, chemical reactions in space and magnetospheric physics. As a scientist, Patricia's own research interests are centered on space weather and ionospheric effects on Global Navigation Satellite Systems (GNSS) and its relevant applications. In addition, Patricia has been very active in promoting research and education in the science of navigation in developing countries.

She is an Associate Editor of the Radio Science Journal, a member of the American Geophysical Union (AGU), Past-president of the Institute of Navigation (ION), Chair of the International Union of Radio Scientists (URSI) Commission G, the URSI representative to the International Committee on GNSS, the Boston College representative to the Universities Space Research Association (USRA) and a member of the USRA Board of Trustees. She is the recipient of numerous awards for research and international outreach including the ION Burka Award, the ION Weems Award, the ION Distinguished Service Award, the 2017 GPS World Leadership Award and the 2018 AGU Carrington Education and Outreach Award. She is a Fellow of the Institute of Navigation and a Fellow of the African Geospace Society.

ABSTRACT: STORMS FROM THE SUN: THE SCIENCE OF SPACE WEATHER

Space Weather is an emerging field of space science that studies how the Sun influences the Earth's space environment and the impacts of those interactions on technology and society. Some of the most intense interactions can damage our Earth-orbiting commercial and scientific satellites; threaten astronaut safety; introduce high levels of radiation for crews and passengers in flights crossing over the poles; disrupt electric power grids, oil pipelines and the reliability and accuracy of global communications and navigation systems, including Global Navigation Satellite Systems (GNSS). With society's ever-increasing dependence on space-based technology, it is important to enhance public awareness of Space Weather, its potential impacts and what governments are doing to enhance forecasting and mitigation of its most damaging effects. This presentation will introduce the basic physical concepts of the source of Space Weather. This includes information on the Sun, solar wind, eruptive solar phenomena, magnetosphere, ionosphere and geomagnetic induction. The presentation will continue with a view of the impacts of Space Weather on technological systems in space and on the ground. Finally, we will introduce plans to advance forecasting capabilities and mitigation of Space Weather.

PROF. STEPHAN WOODBORNE, ITHEMBA LABS

BIOGRAPHY

Stephan Woodborne is the Senior Accelerator Mass Spectrometry Scientist at iThemba LABS (Laboratory for accelerator based sciences). He obtained a Ph.D. in archaeology from the University of Cape Town in 1996 and took up a post -doctoral fellowship at the CSIR where he understudied John Vogel in the radiocarbon dating laboratory. He ran the Quaternary Dating Research Unit (QUADRU) at the CSIR for 15 years, and in this time introduced luminescence dating to compliment the radiocarbon dating facility, and he also diversified the field of stable light isotope analyses in South Africa.

His research interests are in palaeo-science, climate change and ecological processes. He has published more than 80 peer review journal articles in fields as diverse as cholera to social development. He currently manages the stable light isotope laboratory at iThemba LABS, is Associate Professor at the Mammal Research Institute at the University of Pretoria, is Associate Professor in the School of Life Sciences at the University of KwaZulu Natal, and is a research

ABSTRACT: PARTICLE PHYSICS AND CLIMATE CHANGE

Accelerator Mass Spectrometry (AMS) is an applied particle physics technology that is playing an important role in understanding the trajectory of climate change in southern Africa. The Inter-governmental Panel on Climate Change (IPCC) advocates the use of past climate history as a test of the skill of climate models, but the instrumental record of climate variability in southern Africa is short in duration and patchy in distribution.

An approach to climate reconstruction where instrumental records are inadequate is dendrochronology: the recording of climate in the ring widths of trees, but in southern Africa this approach is limited to short-lived tree species. At iThemba LABS we have been attempting to reconstruct past climate using the isotopic chemistry of wood from long-lived trees. The focus has been on baobab trees that can achieve ages in excess of 1000 years, but the ring structures preserved in the wood are not annually formed. Understanding the growth structure of the trees is critical to climate reconstruction. By measuring the rare isotope ¹⁴C using AMS it has been possible to radiocarbon date baobabs. The approach is complicated by the “Suess Effect” where atmospheric ¹⁴C levels were diluted by the addition of “¹⁴C-dead” fossil fuel carbon to the atmosphere since the start of the industrial revolution. It is also complicated by the effect that above ground nuclear testing had on ¹⁴C concentrations in the atmosphere. These effects are overcome and the results show that baobab growth is complex, but it can be unraveled with AMS dating.

By measuring the stable isotope ratios (¹³C/¹²C) of the baobab wood, it has been possible to reconstruct rainfall variability over southern Africa from Namibia to Madagascar over the last 600-1000 years. This record reveals the underlying forcing of climate, and approximately 4 variables control most of the droughts (including the “day-0” drought in Cape Town) in the region. Using this to test climate models shows that the models accurately predict the effects of the 4 underlying variable, and so the alarming climate change forecasts for the region should be given high priority at policy level.

PROF. REGINA MAPHANGA, CSIR

BIOGRAPHY:
Regina Maphanga is a principal researcher at the council for scientific and industrial research – Next Generation Enterprises and Institutions Cluster. Prior to joining CSIR she was an Associate Professor of Physics at the University of Limpopo and is currently appointed as a Research Associate at the same institution. In 2012 Regina was appointed as a Junior Associate at the Abdus Salam International Centre for Theoretical Physics in Italy. Her research focuses on using computer simulations methods to probe materials properties and design new materials, mainly for energy storage.

She is an alumni member of South African Young Academy of Science and Global Young Academy – the voice of the young scientists around the world. Amongst various professional committees she serves, she is an Honorary Secretary and Executive Council Member for South African Institute of Physics and an elected member of C20 Commission on Computational Physics of International Union of Pure and Applied Physics (IUPAP). She received distinguished awards for her outstanding contribution in Science, Engineering and Technology in South Africa. She made continuous contributions to a number of programmes on promotion of public understanding of science, engineering and technology in SA.

Regina has been invited to participate in various young scientists' activities, amongst others World Economic Forum Young Scientist and BRICS Young Scientists Forum. She is involved in various outreach activities on encouraging youth to become future scientists. She is passionate about science communication and occasionally writes science communication essays for Science Magazine of American Association for the Advancement of Science.

ABSTRACT: COMPUTATIONAL MODELLING AS A VALUE-ADD IN MATERIALS DESIGN AND DISCOVERY
Computer modelling has been identified as a key area of growth worldwide and is increasingly becoming a driving force in the discovery and design of novel materials. Currently, computer simulation methods are influencing all areas of study, with a great impact in condensed matter physics, materials science, chemistry and engineering. With the advancement of computing powers, complex materials and their properties are increasing investigated. Methods at different spatiotemporal scales such as density functional theory, molecular dynamics, energy minimization, many-body perturbation theory, phase field and quantum Monte Carlo to continuum macroscopic approaches are employed to simulate materials for various applications. The search to improve and optimize properties and structural characterization of materials is a subject of intense scrutiny.

However, this has proved challenging because of the complex and preparation-dependent microstructure of many materials. Over the last few years, materials science research have been steadily moving from technique development and determination of fundamental properties towards new materials discovery and design guided by computation, machine learning and data mining, also by a closely tied combination of computational predictions and experimental validation. Thus, the design of materials by computation is expected to lead to the discovery of new material and rapid evolution of new materials into products. This talk will broadly highlight recent advances in materials design and discovery, including the application of machine learning techniques in materials science.

PROF. PATRICIA WHITELOCK, SOUTH AFRICAN ASTRONOMICAL OBSERVATORY AND UNIVERSITY OF CAPE TOWN

BIOGRAPHY:
Patricia is an astronomer at SAAO and an Honorary Professor in the Astronomy Department at UCT. Her research has centred on the late stages of stellar evolution, when stars lose material processed by nuclear reactions into the interstellar medium. She has also worked on variable stars, the structure of our Galaxy and on the stellar content of nearby galaxies, using data from SAAO and from various space observatories.

She has over 200 papers in refereed journals. She is an Honorary Member and former President of the SAIP and is the recipient of the 2018 SAIP de Beers Gold Medal. She is also an Honorary Fellow of the Royal Astronomical Society (UK) and a Fellow of the Academy of Science of South Africa. She is a former Director of SAAO and is currently on the Executive Committee of the International Virtual Observatory Alliance and the International Astronomical Union Executive Committee's Working Group on Global Coordination of Ground and Space Astrophysics.

ABSTRACT: WONDERFUL STARS
As stars like the Sun age they undergo various dramatic changes. I will review what we know about the last stage of stellar evolution that is powered by nuclear fusion; know as the Asymptotic Giant Branch (AGB) phase. These extraordinary stars can be intrinsically a thousand times brighter than the Sun, and are a major source of elements, such as carbon, that will form new planets and even contribute to living creatures.

The mass-loss process by which this material leaves the star is still poorly understood and is a focus of new theory and a variety of observations using telescopes around the world, including those in South Africa, and in space. A subgroup of these AGB Stars, the Miras (Latin for wonderful), are strongly variable, regularly changing their visual light output by a factor as much as a thousand times, on time scales ranging from one hundred to several thousand days.

These Miras also have properties that make them useful distance indicators, as observations from SAAO have demonstrated. They will potentially be important to future studies of the distance scale of the universe using the James Webb Space Telescope and the next generation of extremely large ground-based telescopes.

PROF. ALISON B WALKER, UNIVERSITY OF BATH BA2 7AY, UK

BIOGRAPHY:
Alison Walker is a Professor in Physics at the University of Bath. Her research field is materials and device modelling for organic and hybrid organic-inorganic devices for which she is internationally known. She pioneered Kinetic Monte Carlo modelling of organic devices.

She code developed a model for mixed ion-electron conduction in perovskite cells with a mathematics group at Southampton and investigates the electronic structure of perovskites using ab initio molecular dynamics with a chemistry group at Bath. She has over 180 publications and sits on a national panel assessing the excellence of UK physics research.

She coordinates EU H2020 projects Extmos on organic device modelling, and the EU training network Maestro on perovskite cells and is a team leader in projects EoCoE, EoCoE-II and the EU Materials Modelling Council. UK funding includes the Centre for Doctoral Training in New and Sustainable PV, CDT-PV as Academic Director and co-leader and membership of the Super solar Network Plus.

ABSTRACT: REVIEW PROGRESS ON THIRD-GENERATION PHOTOVOLTAIC CELLS
A review progress on third-generation photovoltaic cells, are solar cells designed to overcome the Shockley–Queisser limit of 31–41% power efficiency for single band gap solar cells. These cells are not widely commercially available unlike silicon p-n junction cells b("first generation") and thin film cells ("second generation").

Third-generation cells are made using inexpensive and scalable manufacturing techniques, such as solution processing, but are far less stable than silicon PV. They are either relatively high in efficiency (perovskites cells) or made from non-toxic materials (organic cells), but rarely both. The main focus of my talk will be on how the physics of organic and perovskite cells determines the strengths and limitations of these two technologies.

DR. KATE SHAW, ICTP PHYSICS WITHOUT FRONTIERS

BIOGRAPHY:
Dr. Kate Shaw is an experimental particle physicist working on the ATLAS experiment at CERN, where her research interests are focused on the physics of the top quark and luminosity determination and calibration.

She is lecturer at the University of Sussex, UK, working in the Sussex ATLAS group, and she is a staff scientist at the International Centre for Theoretical Physics (ICTP), Trieste, Italy, where she coordinates the Physics Without Frontiers programme which inspires, trains and educates physics and mathematics students worldwide.

Shaw is passionate about physics outreach and public engagement, for which she won the 2015 EPS outreach prize for outstanding achievement, and works to promote diversity in physics.

ABSTRACT: PHYSICS FOR ALL: REBUILDING OUR COMMUNITY FOR EVERYONE
Physics is an objective and precise science. We are careful to not allow our or anyone else's personal biases, emotions, or cultural influences to effect interpretations of data, characterising the scientific method. However, in the past, and it could be argued still today, we do allow these vices to affect the way we think about the people doing science, be them ourselves or others.

This can cause problems for minority groups in physics, such as women, by not only encountering prejudice, and from lack of confidence, but also due to systems that were designed to suit a specific type of scientist, traditionally who are male. There are many other factors that cross-correlate, such as economic background, geographic location, and ethnicity, that have similar battles but manifested in different ways.

This talk will explore these issues, with some focus on South Africa, and look to how we can become more scientific, in our approach to people, as we are to our data.

SAIP 2019 WINTER SCHOOL

MONDAY 25 JUNE 2019

RENEWABLE ENERGY & ENERGY MATERIALS

09:00 - 09:10	Opening and welcome	**MALUTA NE** University of Venda
09:10 - 10:10	Basic concept in Photovoltaic	**DIALE MM** University of Pretoria
10:15 - 11:15	Review of organic solar cells Historical perspective Recent development and concept improvement	**NTWAEABORWA OM** University of Witwatersrand
11:15 - 11:45	TEA	TEA
11:45 - 12-45	Physics of new materials for nano-sensors and photovoltaics	**MWAKIKUNGA B** CSIR
12:45 - 13:45	LUNCH	LUNCH
13:45 - 14:45	Materials for hybrid organic-inorganic devices	**WALKER AB** University of Bath
14:50 - 15:50	Renewable Energy Markets and technologies: An overview	**RORO K** CSIR
15:50 - 16:00	Closing Remarks	**RAVHENGANI TS** University of Venda

MEETINGS ROOMS SAIP 2019

MEETINGS ROOMS SAIP 2019

Winter School	DAY LILLY
Welcome Reception	WARRIORS/ SAFARI
Plenary	MAKHULU
Registration Area / Registration	WARRIORS/ SAFARI
Poster Session	MAKHULU
Track A - Physics of Condensed Matter and Materials	MELSETTER
Track B - Nuclear, Particle and Radiation Physics	GEORGIAN
Track D1 - Astrophysics	MERLIN 1
Track D2 - Space Science	MERLIN 2
Track E - Physics Education & Teachers Worhsop	DAY LILLY
Track F - Applied Physics & Physics in Industry	BACCHUS
Track G - Theoretical and Computational Physics	ROSE ROOM
Council Meeting	BOARD ROOM
Council Fundraising Meeting Tue 18:00 - 20:00	ROSE ROOM
Council with HoDs Wed 18:00 - 20:00	ROSE ROOM
Council with Division Heads Thur 18:00 - 20:00	ROSE ROOM
M&E Workshop 10 & 11 July	GARDEN ROOM
SAIP AGM Friday 14:00 - 16:00	MAKHULU
Banquet / Gala Dinner	SAFARISAFARI
Teas and Lunch Area	SAFARISAFARI

PHYSICS IN INDUSTRY DAY PROGRAMME

FRIDAY 18 JUNE 2019

TIME	SUGGESTED TOPIC / AREA	PROPOSED PRESENTER
10:00 – 10:40	Intellectual Property, Innovation Management and the Role of NIMPO in Innovation Support in South Africa	NIMPO Rep
10:40 – 11:20	Financing a Start-up and the Role of National Empowerment Fund in Entrepreneurship Support in South Africa	National Empowerment Fund Rep
11:20 – 12:00	Physics outside Academia	Mikhail Sakharov
12:00 – 12:40	Industry-Academia Collaborations – Case Study of Diamond Sorting	Prof Simon Connell
12:40 – 13:00	Discussion of Improving the Physics in Industry	All

CONFERENCE SCIENTIFIC PROGRAMME

Track A - Physics of Condensed Matter & Materials

Track B - Nuclear, Particle & Radiation Physics

Track C - Photonics

Track D1 - Astrophysics

Track D2 - Space Science

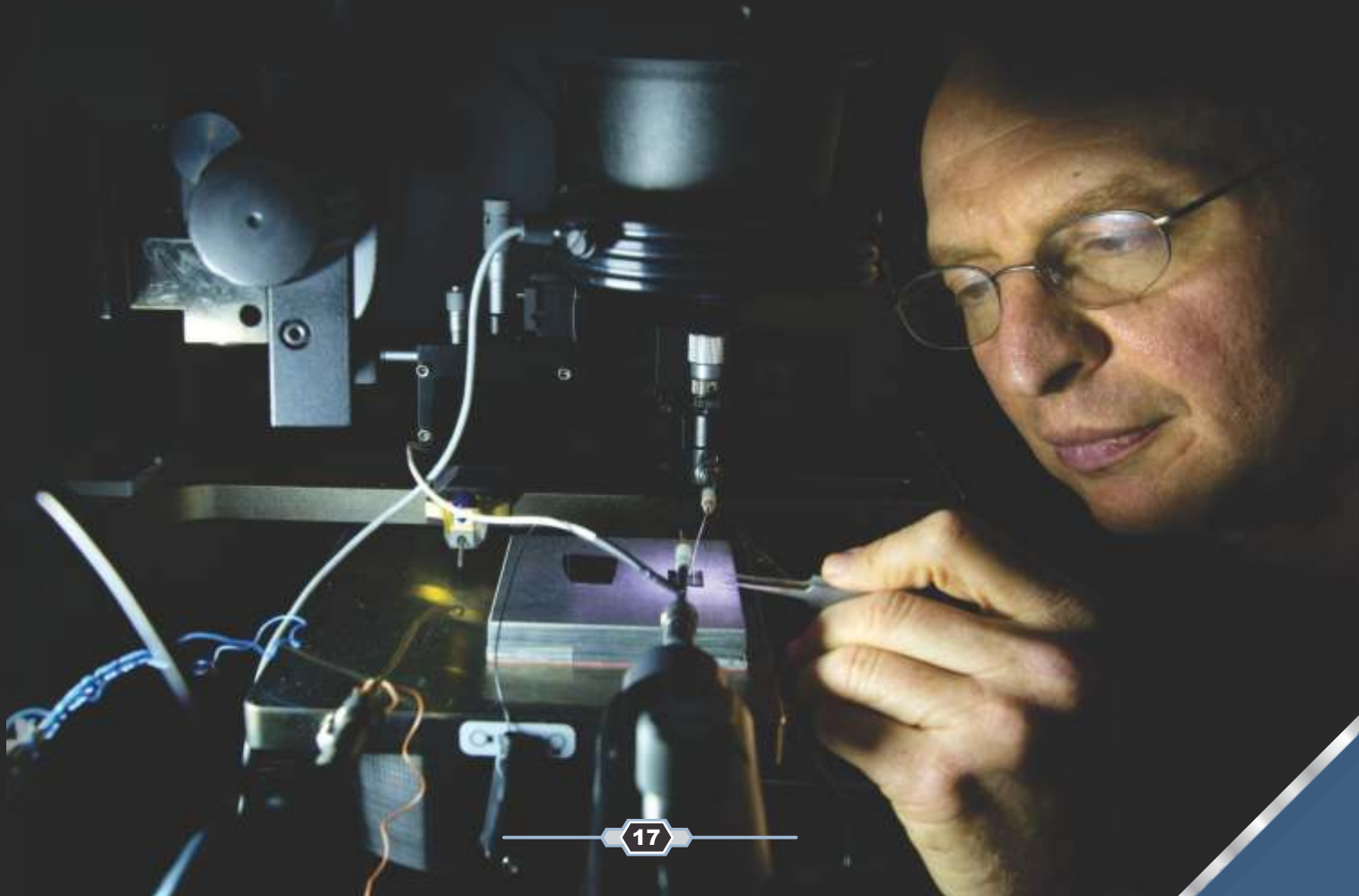
Track E - Physics Education

Track F - Applied Physics

Track G - Theoretical & Computational Physics

Track H - Plenaries

Track I - General



MONDAY
08 JULY 2019
TO
FRIDAY
12 JULY 2019

EVENT PROGRAM

SOUTH AFRICAN INSTITUTE OF PHYSICS

MONDAY : 08 JULY 2019

08:00

SAIP Council Meeting

Protea The Ranch Hotel, Polokwane 08:30 - 16:00

Winter School

09:00

Opening and welcome Dr. Nnditshedzeni Eric MALUTA

Protea The Ranch Hotel, Polokwane 09:00 - 09:15

Basic concepts in Photovoltaic Dr. Mmantsae DIALE

10:00

Protea The Ranch Hotel, Polokwane 09:15 - 10:15

Review of organic solar cells Historical perspective Recent development and concept improvement

Protea The Ranch Hotel, Polokwane 10:15 - 11:15

11:00

Tea Break

Protea The Ranch Hotel, Polokwane 11:15 - 11:35

Physics of new materials for nano-sensors and photovoltaics Dr. Bonex MWAKIKUNGA

12:00

Protea The Ranch Hotel, Polokwane 11:35 - 12:35

Lunch

13:00

Protea The Ranch Hotel, Polokwane 12:35 - 13:45

Materials for hybrid organic-inorganic devices

14:00

Protea The Ranch Hotel, Polokwane 13:45 - 14:45

Renewable Energy Markets and technologies: An overview Dr. Kittessa RORO

15:00

Protea The Ranch Hotel, Polokwane 14:45 - 15:45

Closing Remarks

Protea The Ranch Hotel, Polokwane 15:45 - 16:05

16:00

17:00

Welcome Reception

18:00

Protea The Ranch Hotel, Polokwane *17:00 - 19:00*

19:00

TUESDAY : 09 JULY 2019

08:30 - 09:00	OFFICIAL OPENING		
09:00 - 10:00	PLENARY : Prof. Patricia WHITELOCK WONDERFUL" STARS [344]		
TRACK	APPLIED PHYSICS	ASTROPHYSICS	NUCLEAR, PARTICLE AND RADIATION PHYSICS
THEME CHAIR	DR. FERRER, PHIL (Wits)	DR. VAN SOELEN, BRIAN -	DR. NCHODU, RUDOLPH (iThemba LABS)
10:00 - 10:20	[30] Density functional theory study of copper zinc tin sulphide (Cu2ZnSnS4) doped with calcium & barium [For award: MSc] Mr. MLOTSHWA, Thokozane (Saip and Nitherp)	[126] Investigating thermal and non-thermal emission in novae [For award: PhD] Ms. NYAMAI, Miriam Mumbua (University of Cape Town)	[324] An overview of iThemba LABS cyclotrons and ion sources Dr. SAKILDIEN, Muneer (iThemba LABS)
10:20 - 10:40	[51] Analysis of Type 1 diabetes verbal autopsy data by machine learning techniques [For award: PhD] Ms. MANAKA, Thokozile (Lesotho)	[144] A radiative transfer model for hydrogen recombination line masers [For award: PhD] Ms. PROZESKY, Andri (Unisa)	[325] Production of metal ion beams with the iThemba LABS ECR ion source Dr. MIRA, Joele (iThemba LABS)
10:40 - 11:00	[93] First principle study of hematite (α -Fe2O3) surfaces structure doped with transition metals [For award: MSc] Mr. MABASO, Clarence Vusi (Student)	[1] Astrophysical Transients with MeerKAT and MeerLICHT Prof. WOUDT, Patrick (University of Cape Town)	[326] Beam intensity improvement of high energy heavy ions beams at iThemba LABS Dr. NEMULODI, Fhumulani (iThemba LABS)
11:00 - 11:20	TEA & COFFEE BREAK		
TRACK	APPLIED PHYSICS	ASTROPHYSICS	NUCLEAR, PARTICLE AND RADIATION PHYSICS
THEME CHAIR	DR. FERRER, PHIL (Wits)	DR. VAN SOELEN, BRIAN -	KAR, DEEPAK (University of Witwatersrand)
11:20 - 11:40	[263] Reconfigurable infrared hyperbolic metasurfaces using phase change materials Prof. ABATE, Yohannes (The University of Georgia)	[34] Mira Variables and the Extragalactic Distance Scale Dr. MENZIES, John (South African Astronomical Observatory)	[39] Understanding the J/Psi background in top quark events using proton-proton collision data at a centre-of-mass energy of 13 TeV in ATLAS [For award: MSc] Mr. BARENDS, Kevin Nicholas (University of Cape Town)
11:40 - 12:00	[265] Independence of Inductive kick on Inductance of a Pulse Induction Circuit Dr. WOJUOLA, Olanrewaju (North-West University)	[48] Multi-wavelength study of large-scale outflows from the Circinus galaxy [For award: MSc] Ms. EBRAHIM, Rozeena (School of Physics, University of the Witwatersrand, Johannesburg)	[36] Simulation of the ATLAS ITk Strip Endcap Modules for Testbeam Reconstruction and Analysis [For award: MSc] Mr. ATKIN, Ryan (University of Cape Town)
12:00 - 12:20	[275] Predicting scuffing by modeling bottle movement on a multi-track conveyor. Mr. DEMPERS, Clemens (Blue Stallion Technologies, Centre for Transport Development, Industrial & Systems Engineering, University of Pretoria, South Africa)	[134] NIR imaging analysis of cluster candidates in the Vela Supercluster [For award: PhD] Ms. HATAMKHANI, Narges (University of Cape town)	[148] Analysis of a deep neural network for missing transverse momentum reconstruction with the ATLAS detector [For award: MSc] Mr. LEIGH, Matthew (University of Cape Town)
12:20 - 12:40	[153] Light Dependent Energy Regulation in Phycobilisomes of Cyanobacteria [For award: PhD] Mr. GONFA, Tesfaye (University of Pretoria)	[158] Deep r-band imaging of CLoGS galaxy groups [For award: MSc] Ms. HATTINGH, Sumari (North-West University)	[296] The search for a new scalar and a dark force boson [For award: PhD] NTSOELE, Phineas (University of Johannesburg)
12:40 - 13:00	[86] Construction and testing of a magneto-optical trap for laser cooling of rubidium atoms Dr. GOVENDER, Kessie (Cape Peninsula University of Technology)	[47] Probing the DA and EoR Using Differential Observations of the SZE-21cm [For award: PhD] Mr. TAKALANA, Charles (University of the Witwatersrand)	[108] Searches for Dark Matter via mono-higgs with the ATLAS detector. [For award: MSc] Mr. MDLULI, Karabo (University of the Witwatersrand)
13:00 - 14:00	LUNCH		
14:00 - 15:00	PLENARY : Prof. DOHERTY, Patricia (Institute for Scientific Research) STORMS FROM THE SUN: THE SCIENCE OF SPACE WEATHER [352]		
15:00 - 17:00	POSTER SESSION 1		
18:00 - 20:00	SAIP COUNCIL MEETING: FUNDRAISING & SUSTAINABILITY		

TUESDAY : 09 JULY 2019

OFFICIAL OPENING

PLENARY : Prof. Patricia WHITELOCK
WONDERFUL" STARS [344]

PHYSICS EDUCATION	PHYSICS OF CONDENSED MATTER AND MATERIALS	SPACE SCIENCE	THEORETICAL AND COMPUTATIONAL PHYSICS
DR. RAMAILA, SAM -	Dr. LEDWABA, RAESIBE SYLVIA (University of Limpopo)	Dr KATAMZI-JOSEPH Zama -	PROF. CORNELL, ALAN (University of Johannesburg)
TEACHER DEVELOPMENT WORKSHOP	[61] Investigating the effect of Co addition on the stability of B2 TiPd system using DFT approach [For award: MSc] Ms. DIALE, Ramogohlo (University of Limpopo)	[286] Turbulence conditions at the beginning of the space age: a preliminary analysis [For award: MSc] Mr. WOLMARANS, Carel Pieter (North-West University)	[3] The Equation of State of weak hadron gas from microscopic model [For award: MSc] Mr. NEMAKHAVHANI, Thendo Emmanuel (University of Johannesburg)
	[141] Ab-Initio Investigation of the Electronic Properties of Low Miller Index Surfaces in $LiMn_2O_4$ Spinel. [For award: MSc] Mr. RAMOGAYANA, Brian (UL)	[16] Onset of 2D magnetic reconnection in the solar photosphere, chromosphere and corona Dr. BOTHA, G. J. J. (Northumbria University, UK)	[29] Transport coefficients of relativistic fluids from third order causal theory Dr. YOUNUS, Mohammed (Nelson Mandela University)
	[38] Structural, thermodynamic, electronic and mechanical properties of MCO_3 (M: Ca, Mn, Fe, Co, Ni) precursor materials for Li-ion batteries [For award: MSc] Ms. MORUKULADI, Mogahabo (UL)	[17] Observations of a kink-unstable coronal loop using DKIST/DL-NIRSP and Hinode/EIS Dr. BOTHA, G. J. J. (Northumbria University)	[37] Fluctuating Open Heavy Flavour Energy Loss in a Strongly Coupled Plasma with observables from RHIC and the LHC [For award: MSc] Mr. NGWENYA, Blessed (University of Cape Town)

TEA & COFFEE BREAK

PHYSICS EDUCATION	PHYSICS OF CONDENSED MATTER AND MATERIALS	SPACE SCIENCE	THEORETICAL AND COMPUTATIONAL PHYSICS
DR. RAMAILA, SAM -	DR. JILI, THULANI (University of Zululand)	Dr KATAMZI-JOSEPH Zama -	DR. KUMAR, MUKESH (University of the Witwatersrand)
TEACHER DEVELOPMENT WORKSHOP	[63] The Ab Initio Study of Ti50Pt50-xHfx (x = 6.25, 18.75, 25) Potential Shape Memory Alloys [For award: MSc] Mr. BALOYI, Mphamela Enos (UL)	[284] Solar Observation, Space Weather and the Computation of Sunspot Dynamics Mr. CLINTON DENIS STEVENS, Clinton (North-West University Potchefstroom)	[123] Bottomonia Suppression in Heavy-Ion Collisions from AdS/CFT [For award: MSc] Ms. BARNARD, Nadia (University of Cape Town)
	[146] Ion-implanted Polyaniline thin films for Radiation sensing applications [For award: MSc] Mr. MATOME, Matome (University of South Africa)	[102] Energy losses and propagation times of solar energetic particles [For award: MSc] Mr. VAN DEN BERG, Jabus (North West University)	[253] Extensions of Thermus & its applications in High Energy Particle collisions Dr. WORKU, Dawit (Cape Peninsula University of Technology) Prof. CLEYMANS, Jean (UCT) Mr. PARADZA, Masimba Wellington (UCT-CERN)
	[147] Sol-gel synthesis and characterization of Er3+ doped and Yb3+ co-doped TiO2 nanoparticles [For award: MSc] Mr. TALANE, Tsholo (TUT)	[235] Long-term cosmic-ray modulation: a multi-decade approach [For award: PhD] Mr. MOLOTO, Katlego (North West University)	[279] Simulations in large N gauge theories with finite chemical potential Dr. BASU, Pallab (Senior Lecturer)
	[137] XRD, Mössbauer and magnetic study of MxCo1-xFe2O4 (M = Zn or Cd) nanoparticles [For award: MSc] Mr. MASUKU, Sizwe (University of Zululand)	[276] On the Effects of Dissipation Range Turbulence on the Perpendicular Difusion Coefficients of Cosmic Ray Electrons [For award: Hons] Ms. DEMPERS, Nadine (North-West University)	[312] Theory of equation of state and transport coefficients for relativistic hydrodynamics in Heavy Ion Collisions and Binary Neutron Star Collisions Prof. MURONGA, Azwinndini (Nelson Mandela University)
	[91] Elastic and Thermal properties of phase change materials (PCM): Sb2Te3 and Ge1Sb4Te7 [For award: MSc] Mr. TJALE, Phuti Balty (WITS)	[170] Effects of scattering parameters on charge-sign-dependent cosmic ray modulation Dr. NGOBENI, Mabedle (North West University)	[117] A Deep Learning approach to the search for gg in association with missing energy at the ATLAS detector [For award: MSc] Mr. GAELEJWE, Theodore (University of the Witwatersrand)

LUNCH

PLENARY : Prof. DOHERTY, Patricia (Institute for Scientific Research)
STORMS FROM THE SUN: THE SCIENCE OF SPACE WEATHER [352]

TRACK	PHYSICS EDUCATION
THEME CHAIR	MR. PHAGE, ITUMELENG (Honorary)
15:00 - 15:20	[209] Students' approaches to solving problems kinematic problems Dr. HERBERT, Mark (University of the Western Cape)
15:20 - 15:40	[210] The two stage test: a form of collaborative and reflective learning Dr. HERBERT, Mark (University of the Western Cape)
15:40 - 16:00	[60] Modelling instruction in ECP Dr. JOHN, Ignatius (Cape Peninsula University of Technology)

TRACK	PHYSICS EDUCATION
THEME CHAIR	MR. KHWANDA, MPHIRISENI (UJ)
16:00 - 16:20	[79] An effective solution to a many-bodied problem in first-year physics [For award: PhD] Mr. DIX-PEEK, Ross (NMMU)
16:20 - 16:40	
16:40 - 17:00	[205] Teaching Problem Solving: The "10 Commandments" Approach [For award: MSc] Ms. MATIWANE, Noluvuyo (Rhodes University)

TRACK	PHYSICS EDUCATION
THEME CHAIR	PROF. NAIDOO, DEENA (University of the Witwatersrand)
17:00 - 17:20	[190] Are we giving our students more than we should? Dr. SONDEZI, Buyi (University of Johannesburg)
17:20 - 17:40	[239] A re-look at the sequence of concepts in our curriculum Mr. MOLEFE, Paul (University of Johannesburg) Dr. SONDEZI, Buyi (University of Johannesburg)
17:40 - 18:00	[133] The Educational Power of Being wrong Mr. HORSZOWSKI, Peter (Pert Industrials)

WEDNESDAY : 10 JULY 2019

08:30 - 09:00	ANNOUNCEMENTS		
09:00 - 10:00	PLENARY : Dr. Kate SHAW (CERN) PHYSICS FOR ALL: REBUILDING OUR COMMUNITY FOR EVERYONE [350]		
TRACK	APPLIED PHYSICS	ASTROPHYSICS	NUCLEAR, PARTICLE AND RADIATION PHYSICS
THEME CHAIR	DR. USMAN, IYABO (University of the Witwatersrand)	DR. VAN SOELEN, BRIAN -	DR. NEMULODI, FHUMULANI (iThemba LABS)
10:00 - 10:20	[157] Correlation of Thermal Imaging and Current-Voltage characteristics of PV module strings Mr. VUMBUGWA, Monphias (Nelson Mandela University)	[41] Astronomical opportunities for HBU's Dr. JILI, Thulani (University of Zululand)	[327] Fluka Monte Carlo simulation of gamma photon transport through a distillation column, designed using ChemSep software Mr. CHIRUME, Witness (National University of Science and Technology)
10:20 - 10:40	[168] A Deployable Modular Mini-Grid for Electrification in Rural Areas Dr. SCHULTZ, Ross (NMU)	[314] The interpretation of broadband data from radio pulsars [For award: MSc] Ms. RAMMALA, Isabella (Rhodes University)	[328] Monte-Carlo Shielding Calculations for a 10-MeV Electron Accelerator in Botswana Mr. TIKOLOGO, Otsile (BIUST)
10:40 - 11:00	[187] Energy management strategy for a remote area power system in rural application [For award: MSc] Mr. GOVUZELA, Mnoneleli (Nelson Mandela University)	[131] Emission constraints for the white dwarf pulsar via modelling of its phase-resolved polarisation signatures [For award: MSc] Mr. DU PLESSIS, Louis (NWU, Potchefstroom, Department of Physics)	[329] Geant4 in a new role – Reactor Physics Prof. CONNELL, Simon (University of Johannesburg)
11:00 - 11:20	TEA & COFFEE BREAK		
TRACK	APPLIED PHYSICS	ASTROPHYSICS	NUCLEAR, PARTICLE AND RADIATION PHYSICS
THEME CHAIR	DR. FERRER, PHIL (Wits)	DR. VAN SOELEN, BRIAN -	DR. NCHODU, RUDOLPH (iThemba LABS)
11:20 - 11:40	[129] Experimental validation of the hot mirror system Dr. FERRER, Phil (WITS)	[96] Orbitally-Modulated X-ray and Gamma-ray Emission from Millisecond Pulsar Binaries [For award: MSc] Mr. VAN DER MERWE, Christian (North-West University, Centre for Space Research)	[333] Study of total, complete and incomplete fusions Mr. MUKERU, Bahati (UNISA)
11:40 - 12:00	[179] Thermal performance analysis of novel alternative designs for parabolic trough solar collector [For award: PhD] Mr. MOHAMAD, Khaled (Witwatersrand University)	[200] Opacities to very high energy gamma rays in the blazar jets [For award: MSc] Mr. NTSHATSHA, Mfuphi (University of Johannesburg)	[334] Angular correlation measurements with a segmented clover detector Ms. MTHEMBU, Sinegugu Happiness (iThemba LABS)
12:00 - 12:20	[169] Reporting on the Southern African Reference Energy Yield Network System (SAREYNS) Dr. SCHULTZ, Ross (NMU)	[161] Phenomenology of axion-photon coupling in the jets of AGNs [For award: PhD] Mr. ALI, Ahmed Ayad Mohamed (University of the Witwatersrand)	[335] Developing Nuclear Forensics Signatures in the Southern African Region: A case study of South Africa and Namibia Prof. MATHUTHU, Manny (North West University - Mafikeng)
12:20 - 12:40	[191] The potential and effect of diffusion capacitance on fast point-by-point Current-Voltage measurements of photovoltaic cells in LBIC Dr. VORSTER, Frederik (NMMU)	[54] Constraining the star formation history with Fermi-LAT observations of the gamma-ray opacity of the universe [For award: MSc] Ms. LE RAY, Ashlynn (University of the Witwatersrand)	[337] New Collective Structures in the Z = 76 Stable Odd Neutron Nucleus 187Os
12:40 - 13:00	[193] Photovoltaic array performance parameter extraction using only Maximum Power Point Traced data [For award: MSc] Mr. CHITURA, Anesu (University of Fort Hare)	[207] Application of the adiabatic compression scenario to the radio relic in the galaxy cluster A3411-3412 [For award: MSc] Ms. BUTTON, Charissa (University of the Witwatersrand)	[338] Search for collective structures in 186Os Mr. MDLETSHE, Linda (iThemba Laboratory for Accelerator Based Sciences)
13:00 - 14:00	LUNCH		
TRACK	APPLIED PHYSICS	ASTROPHYSICS	NUCLEAR, PARTICLE AND RADIATION PHYSICS
THEME CHAIR	DR. FERRER, PHIL (Wits)	- -	PROF. MATHUTHU, MANNY (North West University- Mafikeng)
14:00 - 14:20	[82] Electroluminescence Module Mismatch Analysis (EMMA) [For award: PhD] Mr. DIX-PEEK, Ross (NMMU)		[330] Design of a national indoor radon survey for South African Homes: review of existing indoor radonconcentration data and associated measurement techniques Mr. MAHESO, Abbey (Stellenbosch University)
14:20 - 14:40	[227] Sizing optimisation and installation of a stand-alone PV water pumping system for irrigation Mr. MASEVHE, Livhuwani (UNIVEN) Dr. MALUTA, Eric (UNIVEN)		[331] Radioactivity assessment of Uranium Isotopes concentration in water sources at and near selected formeruranium mines in the West-Rand area of Johannesburg Ms. MOHLALA, Nthabiseng Sylvia (University of Witwatersrand)
14:40 - 15:00	[19] Nanocrystalline Silicon Devices for Radiation Sensing Applications [For award: PhD] Mr. OEBA, Duke (University of South Africa)		[332] Determining the Radon Emanation Coefficient for soil sample Ms. PHEFO, Lebogang (University of Zululand)
15:00 - 15:20	[67] Quantum Metamaterials: The past, current and future perspective on quantum communication and information science. Dr. URIRI, Solomon (University of KwaZulu-Natal)		[336] Toxicity of Natural Radioactivity in Water Samples from a Gold Mine in Gauteng Province, South Africa Mr. KAMUNDA, Caspah (North West University - Mafikeng)

WEDNESDAY : 10 JULY 2019

ANNOUNCEMENTS			
PLENARY : Dr. Kate SHAW (CERN) PHYSICS FOR ALL: REBUILDING OUR COMMUNITY FOR EVERYONE [350]			
PHYSICS EDUCATION	**PHYSICS OF CONDENSED MATTER AND MATERIALS**	**SPACE SCIENCE**	**THEORETICAL AND COMPUTATIONAL PHYSICS**
DR. RAMAILA, SAM -	**DR. LETSOALO, THABO** **(University of Limpopo)**	- -	**DR. HOROWITZ, WILLIAM** **(University of Cape Town)**
TEACHER DEVELOPMENT WORKSHOP	[149] First Principle Study of Metal Oxide 110 β-MO_2 (M= Ti, Mn, V) Surfaces Stability and their Interaction with Li_2O_2 [For award: Hons] Mr. NGOBENI, Percy (UL)		[71] Dark matter in the Randall-Sundrum model Dr. KUMAR, Mukesh (University of the Witwatersrand)
	[77] Computational modelling on Stability of Solid Electrolytes in Magnesium ion batteries [For award: Hons] Mr. TIBANE, Khumbulani (UL)		[202] The Coalescence Rate of Binary Neutron Stars and Black Hole-Neutron Star Systems [For award: Msc] Mr. NYADZANI, Lutendo (University of Johannesburg)
	[198] Atomistic Simulation Studies of Layered Li2MnO3 Nanospherical Cathode Materials [For award: Hons] Mr. TSEBESEBE, Nkgaphe (University of Limpopo)		A 2+1D Monte Carlo generator for Jets in Heavy Ion Collisions Ms. KOLBE, Isobel (University of Cape Town)
TEA & COFFEE BREAK			
PHYSICS EDUCATION	**PHYSICS OF CONDENSED MATTER AND MATERIALS**	**SPACE SCIENCE**	**THEORETICAL AND COMPUTATIONAL PHYSICS**
DR. RAMAILA, SAM -	**DR. MODIBA, ROSINAH** **(CSIR)**	**Dr KATAMZI-JOSEPH Zama** -	**PROF. MURONGA, AZWINNDINI** **(University of Johannesburg)**
TEACHER DEVELOPMENT WORKSHOP	[194] the synthesis and characterization of tungsten Oxide WO3 nanostructures thin films for gas sensing applications [For award: MSc] Mr. MPANZA, Thokozani (University of Zululand)	[46] Cosmic radiation and space exploration Dr. STRAUSS, Du Toit (Centre for Space Research, North-West University)	[9] Calculation of the Higgs mass in GHU: SU(3)W × SU(3)C Prof. CORNELL, Alan (University of Johannesburg)
	[197] Simulated synthesis of Li-intercalated layered (Li2MnO3)-spinel (LiMn2O4) composite nanoarchitectures. [For award: MSc] Mr. HLUNGWANI, Donald (UL)	[35] Fast ion-acoustic soliton stopbands in plasmas with two-temperature kappa-distributed electrons Dr. MAHARAJ, Shimul (South African National Space Agency (SANSA) Space Science)	[13] A non-minimal composite Higgs model [For award: PhD] Ms. MASON, Lara (SA-CERN)
	[224] Effect of annealing at different time interval on the structure, morphology and optical properties of MgAl2O4:0.1% Mn2+ nanophosphors [For award: MSc] Mr. DLAMINI, Clinton (SMU)	[49] The effects of drifting warm ions on fast ion-acoustic soliton stopbands Dr. MAHARAJ, Shimul (South African National Space Agency (SANSA) Space Science)	[120] Explaining muon $g-2$ in a 2HDM+S model Dr. KUMAR, Mukesh (University of the Witwatersrand)
	[206] Stress-Induced Structural Changes of Lithiated Li1+xMn2O4 ($0 \leq x \leq 1$) Nanoporous Electrode Materials [For award: MSc] Ms. SHIBIRI, Beauty (University of Limpopo)		[177] Non-Abelian Corrections for Radiation in QCD Dr. HOROWITZ, William (University of Cape Town)
	[223] Structural analysis of Ti/LiCl at different temperatures [For award: MSc] Ms. MAZIBUKO, Andile (University of Limpopo)		[304] Higgs Production through Gluon Fusion via intermediate Top quark loop [For award: PhD Ms. SINHA, Sukanya (The University of Witwatersrand)
LUNCH			
PHYSICS EDUCATION	**PHYSICS OF CONDENSED MATTER AND MATERIALS**	**SPACE SCIENCE**	**THEORETICAL AND COMPUTATIONAL PHYSICS**
DR. HERBERT, MARK **(University of the Western Cape)**	**DR. CARLESCHI, EMANUELA** **(University of Johannesburg)**	**Dr KATAMZI-JOSEPH Zama** -	**PROF. BRAUN, MORITZ** **(University of South Africa)**
[241] Inquiry based learning in Optics : Study of students' understanding of image formed by a converging lens and concave mirror Dr. KUDINHA, Martin Tarisai (CPUT)	[107] Computer simulation study of HF molecule adsorption on TiO2 rutile surfaces [For award: PhD] Mr. TSHWANE, David (University of Limpopo/CSIR)	[319] ASTRO & SPACE AGM	[115] The Role of Topology in Quantum Communication Dr. SENEKANE, Makhamisa (National University of Lesotho)
[122] A study on High School Learners' Apathy to Physics Subject – Case Study of High Schools in Kano Municipality Kano State Nigeria. Mr. EZEKIEL, Itegbeyogene (National Centre for Technology Management, Nigeria)	[121] Cobalt ion implantation induced modification in band gap, thermal parameters and lattice strain on RF – magnetron sputter deposited Zinc Oxide thin films on borosilicate glass [For award: PhD] Mr. OLUWALEYE, Olakunle (University of South Africa)		[127] Can bath-induced coherences be useful for thermodynamic tasks? Dr. LOMBARD LATUNE, Camille (UKZN)
[236] Physics student teachers' perceptions, experiences and their assessment of the teacher education programme. A case study of one South African University [For award: PhD] Mr. MOLEFE, Paul (University of Johannesburg)	[180] Influence of Surface Kinetics and Induced Defects on Gas Sensing Characteristics of TiO2 nanostructures [For award: PhD] Ms. TSHABALALA, zamaswazi Portia (DST/CSIR National Centre for Nano-Structured Materials)		[220] Analytical and Numerical Approaches to the quantum optical implementation of Open Quantum Walks [For award: PhD] Mr. ZUNGU, Ayanda (North-West University - Mafikeng)
	[199] Fabrication of inorganic quantum dots (QDs) sensitizer absorbers thermalized from lead dithiocarbamates single-source precursors complexes [For award: PhD] Mr. AGORO, Mojeed Adedoyin (University of Fort Hare)	Dr. KATAMZI-JOSEPH, Zama Thobeka (South African National Space Agency)	[245] Non-repeating Open Quantum Walks [For award: PhD] Mr. GOOLAM HOSSEN, Hazmatally (UKZN)

WEDNESDAY : 10 JULY 2019

15:20 - 15:40	TEA & COFFEE BREAK		
TRACK	APPLIED PHYSICS	ASTROPHYSICS	NUCLEAR, PARTICLE AND RADIATION PHYSICS
THEME CHAIR	DR. FERRER, PHIL (Wits)	- -	- -
15:40 - 16:00	[94] MLEM reconstruction of multiple point sources for UCT PET detector [For award: MSc] Mr. MAHLANGU, Moment (University of Cape Town)		
16:00 - 16:20	[98] Real-time Performance Control and Monitoring for the PPr-TDAQ integration of ATLAS Upgrades for HL-LHC [For award: PhD] Mr. GOLOLO, Mpho Gift Doctor (University of the Witwatersrand)		
16:20 - 16:40	[101] Reliability testing and upgrade of a Low Voltage Power Supply design for the Front-End Electronics of the ATLAS Tile Calorimeter [For award: Msc] Mr. NKADIMENG, Edward (University of the Witwatersrand)		
16:40 - 17:00	[192] Investigating the Feasibility of using Neutron Activation to Measure Elemental Pollution in the Richards Bay Area [For award: MSc] Mr. MHLONGO, Sizwe (University of the Western Cape)		

17:00 - 18:00	TOWN HALL NATIONAL INSTITUTE FOR THEORETICAL AND COMPUTATIONAL SCIENCES (NITheCS) DR. HOROWITZ, William (University of Cape Town) PROF. GLEDHILL, Irvy (Igle) (University of Witwatersrand)

17:00 - 18:00	PHYSICS BOWL

18:00 - 20:00	SAIP COUNCIL MEETING: COUNCIL MEETING WITH HODS

WEDNESDAY : 10 JULY 2019

TEA & COFFEE BREAK			
PHYSICS EDUCATION	**PHYSICS OF CONDENSED MATTER AND MATERIALS**	**SPACE SCIENCE**	**THEORETICAL AND COMPUTATIONAL PHYSICS**
-	**DR. AVULA, BALAKRISHNA (University of The Free State)**	-	**Dr. BASU, PALLAB (Senior Lecturer)**
-		-	
	[217] Magnetic properties of a distorted Kagomé lattice: Gd3Os4Al12 [For award: PhD] Ms. DJOUMESSI FOBASSO, Redrisse (University of Johannesburg)		[309] Relativistic Bell correlations and accelerations [For award: PhD] Mr. HARTMAN, Jonathan (University of Johannesburg)
	[234] Assessment of Remaining Life and Microstructure Degradation of Creep Exposed High – Pressure Rotor Steels [For award: PhD] Mr. NYEMBE, Hlanganani (Nelson Mandela University)		
	[15] Structural, Mössbauer, magnetic and optical studies of Sn0.2FexCr1.8-xO3 nano oxides prepared by reflux and pressure reactor methods Mr. NSIO, Nzundu Tony (University of Namibia)		
	[283] Stability of excitonic states in an extrinsec semiconductor using feynman path integrals [For award: PhD] Mrs. M F C, Fobasso (University of Dschang)		

TOWN HALL
NATIONAL INSTITUTE FOR THEORETICAL AND COMPUTATIONAL SCIENCES (NITheCS)

DR. HOROWITZ, William
(University of Cape Town)
PROF. GLEDHILL, Irvy (Igle)
(University of Witwatersrand)

PHYSICS BOWL

SAIP COUNCIL MEETING:
COUNCIL MEETING WITH HODS

THURSDAYS : 11 JULY 2019

08:30 - 09:00	ANNOUNCEMENTS		
09:00 - 10:00	PLENARY : Prof. Alison WALKER (UNIVERSITY OF BATH) A REVIEW OF PROGRESS ON THIRD-GENERATION PHOTO-VOLTAIC CELLS [347]		
TRACK	APPLIED PHYSICS	ASTROPHYSICS	NUCLEAR, PARTICLE AND RADIATION PHYSICS
THEME CHAIR	DR. FERRER, PHIL (Wits)	DR. VAN SOELEN, BRIAN -	KEAVENEY, JAMES MICHAEL (N/A)
10:00 - 10:20	[251] Novel Fibre Bragg Grating BasedAll Optical OADM for Flexible Spectrum Channel Reservation to Minimize Optical CrossTalk in WDM optical communication networks Ms. PHUMLA, Dlamini (Nelson Mandela University)	[11] Theoretical modelling of a new class of anisotropic compact stellar model compatible with observational data Dr. DAS, Shyam (P. D. Women's College, Jalpaiguri, India)	[110] Top-quark background estimation for physics Beyond Standard Model in the dilepton and jets final state with theATLAS detector [For award: MSc] Mr. MONNAKGOTLA, Jeremiah (University of the Witwatersrand)
10:20 - 10:40	[271] Optical sensitivity of CdS-Au nanocom-posites prepared by physical techniques: pulsed laser deposition and sputter coating. [For award: MSc] Mr. NQAYI, sibusiso (UFS)	[139] Shaken, not stirred: Test particles in binary black hole mergers. [For award: MSc] Mr. VAN DER MERWE, Pieter (North-west University, Center for Space Research)	[85] Implementing a robust anti-QCD tagger with mass de-correlated jet image data [For award: MSc] Mr. RAPETSOA, Kokotla (University of Venda)
10:40 - 11:00	[248] The impact of the kelvin redefinition on temperature measurements for meteorology and climatology Dr. MAPHAHA, Nonhlanhla Precious (National Metrology Insitute of SouthAfrica)	[171] Unifying Dark Matter and Dark Energy in Chaplygin Gas Cosmology [For award: MSc] SWART, Anna-Mia (North-West University)	[128] Optimising the top-quark reconstruction for the W$^\prime$ search in the hadronic channel [For award: MSc] Mr. MHLANGA, Fortune (University of the Witwatersrand)
11:00 - 11:20	TEA & COFFEE BREAK		
TRACK	APPLIED PHYSICS	ASTROPHYSICS	NUCLEAR, PARTICLE AND RADIATION PHYSICS
THEME CHAIR	DR. FERRER, PHIL (Wits)	DR. VAN SOELEN, BRIAN -	PROF. CONNELL, SIMON (University of Johannesburg)
11:20 - 11:40	[258] Nickel substituted Spinel-type zinc ferrite nanostructures prepared by microwave-assisted hydrothermal and their structural, luminiscence and gas sensing properties [For award: Msc] Mr. NEMUFULWI, Murendeni (CSIR/UFS)	[21] Multi-messenger hunts for heavy WIMP Dr. BECK, Geoff (University of Witwatersrand)	[103] Studies on Isolation efficiency scale factors using the Tag and Probe method in the H→ZZ→4l channel for theATLAS detector [For award: MSc] Ms. MTINTSILANA, Onesimo (University of Witwatersrand)
11:40 - 12:00	[277] Response surface methodology optimiza-tion of adsorption and kinetics of Ca removal from aqueous solution using macadamia nutshell biochar [For award: PhD] Prof. ANTOINE F, Antoine (University of Johannesburg)	[164] Neutrino detections inTidal disruption events. [For award: MSc] Ms. RABYANG, Omphile (North West University)	[105] High mass VBF Categorization for the four lepton H→ZZ→ 4l final state with theATLAS detector [For award: MSc] Mr. THABEDE, Mzwandile (University of the Witwatersrand)
12:00 - 12:20	[225] Material composition and thermal analysis of bunker gears used by firefighters in the City of Johannesburg [For award: Msc] Mr. MOKOANA, Vinvent (Tshwane University of Technology and City of Johannesburg EMS)	[27] Costraining f(R)-gravity with cosmological data [For award: MSc] Mr. HOUGH, Renier (North-West University)	[106] Search for a new heavy boson in bbyy channel with ATLAS detector in pp at $\sqrt{s}$ = 13 TeV [For award: PhD] Ms. SHRIF, Esra (University of the Witwatersrand)
12:20 - 12:40	[269] Analytical modelling of thermal properties of possible fuel materials for aluminum smelting Mr. JANVIER, Kamanda (University of Johannesburg)	[242] Unifying the Background with Perturbations in Chaplygin-gas Cosmology [For award: PhD] Ms. ABDULRAHMAN, Heba (North-West University)	[112] Automation of next-to-leading order computations in QCD of the WWjj Background for the Dilepton Final State [For award: MSc] Mr. MOKOENA, Lebohang (University of the Witwatersrand)
12:40 - 13:00			[204] Anomalies in the production of leptons at the LHC Prof. MELLADO, Bruce (University of the Witwatersrand)
13:00 - 14:00	LUNCH		
14:00 - 15:00	PLENARY : Prof. WOODBORNE, Stephan (iThemba LABS) PARTICLE PHYSICS AND CLIMATE CHANGE [345]		
TRACK	APPLIED PHYSICS	ASTROPHYSICS	NUCLEAR, PARTICLE AND RADIATION PHYSICS
THEME CHAIR	DR. FERRER, PHIL (WITS)	- -	PROF. CONNELL, SIMON (University of Johannesburg)
15:00 - 17:00	Applied Physics: Division Meeting		[Nuclear, Particle and Radiation Physics: Division Meeting [320] NUCLEAR PRP AGM Prof. MELLADO, Bruce (University of the Witwatersrand)

15:00 - 17:00	POSTER SESSION 2

18:00 - 20:00	COUNCIL MEETING WITH DIVISION CHAIRS

THURSDAYS : 11 JULY 2019

ANNOUNCEMENTS

PLENARY : Prof. Alison WALKER (UNIVERSITY OF BATH)
A REVIEW OF PROGRESS ON THIRD-GENERATION PHOTO-VOLTAIC CELLS [347]

PHYSICS EDUCATION	PHYSICS OF CONDENSED MATTER AND MATERIALS	SPACE SCIENCE	THEORETICAL AND COMPUTATIONAL PHYSICS
MR. MOLEFE, PAUL (University of Johannesburg)	**PROF. MOTLOUNG, SETUMO VICTOR (SMU)**	- -	**DR. WORKU, DAWIT (Cape Peninsula University of Tech.)**
[213] The teacher development and training program for in-service teachers in the Department of Physics andAstronomy at the University of the Western Cape Dr. HERBERT, Mark (University of the Western Cape)	[278] Unraveling the combined influence of Oxygen vacancies and functional pillared effect on scalable Ni-Co LDH based high performance supercapacitor electrode materials properties Mr. NYONGOMBE EKAMBO, Gayi (UNISA)		[55] Impact-response study of lattice waves and phonons in metallic fcc nanoclusters using the Sutton-Chen potential Dr. OCAYA, Richard (UFS)
[212] A Case for Physics Content Knowledge & Modeling Pedagogy for Natural Science Teachers [For award: PhD] Mr. AUDU, Bako Nyikun (University of the Western Cape) Dr. HERBERT, Mark (University of the Western Cape)	[52] CsMn4As3: A new layered tetragonal pnictide compound with an antiferromagnetic ground state Dr. PANDEY, Abhishek (University of the Witwatersrand)		[136] Mode-Mixing in Nanoeggs [For award: PhD] Mr. UGWUOKE, Luke (University of Pretoria)
[261] Ideas around using Google Earth as a pedagogic tool for teaching wave concepts in the era of Industry 4.0 Dr. CARLESCHI, Emanuela (University of Johannesburg)	[78] On the combined analysis of luminescence for thermal assistance and thermal quenching Prof. CHITHAMBO, Makaiko (Rhodes University)		[272] Molecular Finite Element Density Functional Calculations employing a Cusp Factor Prof. BRAUN, Moritz (University of South Africa)

TEA & COFFEE BREAK

PHYSICS EDUCATION	PHYSICS OF CONDENSED MATTER AND MATERIALS	SPACE SCIENCE	THEORETICAL AND COMPUTATIONAL PHYSICS
DR. JOHN, IGNATIUS (CPUT)	**DR. ERASMUS, RUDOLPH (University of the Witwatersrand)**	**Dr KATAMZI-JOSEPH Zama** -	**PROF. CORNELL, ALAN (University of Johannesburg)**
[211] Support program for first year main stream student outside the normal lectures and tutorial in the Department of Physics and Astronomy at the University of the Western Cape Dr. MARK, Herbert (University of the Western Cape)	[306] Overview of photoemission spectroscopy as a tool for electronic structure investigations of materials	[255] An investigation into sources of pc5 pulsations during quiet geomagnetic conditions [For award: MSc] Mr. MBANJWA, Njabulo (UKZN)	[281] Finite element modelling of thermal stress on lining of a crucible furnace Mr. PODILE, Mpho (University of Johanensburg)
[240] An evaluation of the impact of scientific explanation model on pre-service teachers' understanding of basic concepts in electricity [For award: PhD] Mr. KHWANDA, Mphiriseni (University of Johannesburg)	Dr. CARLESCHI, Emanuela (University of Johannesburg)	[72] Counter-electrojet occurrence as observed from C/NOFS satellite and ground-based magnetometer data over the African and American sectors Dr. HABARULEMA, John Bosco (South African National Space Agency)	[273] Solving differential equations of Quantum Mechanics in 1 D and 2 D using Sinc functions employing Python and Numpy. [For award: MSc] Mrs. EZENWACHUKWU, Obiageli Lovenda (UNISA)
[178] Perceptions of preservice teachers on the impact of the use of media in the teaching and learning of Physical Science in schools [For award: PhD] Mr. PHAGE, Itumeleng (University of Free State)	[317] DPCMM AGM	[182] Multi-instrument observations of atmospheric gravity waves over South Africa Dr. KATAMZI-JOSEPH, Zama Thobeka (South African National Space Agency)	[321] Theoretical Division AGM Prof. MÜLLER-NEDEBOCK, Kristian (University of Stellenbosch)
[294] Death of an Outcome Revisited Dr. CLERK, Douglas (University of the Witwatersrand)	Dr. ERASMUS, Rudolph (University of the Witwatersrand)	[183] Observations of large-scale AGWs/TIDs during enhanced auroral activity on 6 January 2014 Dr. KATAMZI-JOSEPH, Zama Thobeka (South African National Space Agency)	

LUNCH

PLENARY : Prof. WOODBORNE, Stephan (iThemba LABS)
PARTICLE PHYSICS AND CLIMATE CHANGE [345]

PHYSICS EDUCATION	PHYSICS OF CONDENSED MATTER AND MATERIALS	SPACE SCIENCE	THEORETICAL AND COMPUTATIONAL PHYSICS
- -	- -	- -	- -

POSTER SESSION 2

COUNCIL MEETING WITH DIVISION CHAIRS

FRIDAY : 12 JULY 2019

08:30 - 09:00	ANNOUNCEMENTS			
09:00 - 10:00	PLENARY : Prof. Alison WALKER (UNIVERSITY OF BATH) A REVIEW OF PROGRESS ON THIRD-GENERATION PHOTO-VOLTAIC CELLS [347]			
TRACK	APPLIED PHYSICS	NUCLEAR, PARTICLE AND RADIATION PHYSICS	PHYSICS OF CONDENSED MATTER AND MATERIALS	PLENARY: DEPARTMENT OF SCIENCE AT TECHNOLOGY SESSION (DST)
THEME CHAIR	DR. USMAN, IYABO (WITS)	DR. MIRA, JOELE (iThemba LABS)	DR. ERASMUS, RUDOLPH (WITS)	
10:00 - 10:20	[342] Intellectual Property, Innovation Management and the Role of NIMPO in Innovation Support in South Africa (NIPO)	[360] Electronic stopping force of 16O and 63Cu ions in Tantalum Nitride thin films by Time of Flight spectrometry Mr. NKWASHU, Thabiso (University of South Africa)	Physics of Condensed Matter and Materials	10:00 - 10:30 **[348] African Astronomical Society & IAU GA2024** Mr. NEMAUNGANI, Douglas Takalani (Acting Chief Director)
10:20 - 10:40		[361] Internal conversion coefficients from conversion electron sources Mr. ZIKHALI, Bonginkosi (University of Wersten Cape)		10:30 - 11:00 **[349] SKA HCD Programme and Research Highlights**
10:40 - 11:00	[341] Financing a Start-up and the Role of National Empowerment Fund in Entrepreneurship Support in South Africa (NEF Rep)			
11:00 - 11:20		TEA & COFFEE BREAK		
11:20 - 11:40	[340] Physics outside Academia (Mikhail Sakharov)	Nuclear, Particle and Radiation Physics	[92] Effect of Synthesis Approach on the Structural and Optical Properties of Hybrid Perovskite Materials for Photovoltaic Application Mr. OLALERU, Akin (University of Venda)	11:20 - 12:20 **[351] Reporting on the findings of Physics scientometric study**
11:40 - 12:00			[238] Perspectives on the Crystal Growth of Oxygen and Manganese Compensated Li-Rich Layered Nanoparticles Dr. LEDWABA, Raesibe Sylvia (University of Limpopo)	
12:00 - 12:20	[339] Industry-Academia Collaborations – Case Study of Diamond Sorting Industry		[132] The influence of ammonium hydroxide solution on ZnAl2O4 nanophosphor prepared by chemical bath deposition method Mrs. MHLONGO, Motlalepula Rebecca (Sefako Makgatho University)	
12:20 - 12:40	Prof. CONNELL, Simon (University of Johannesburg)		[291] Composition induced structural evaluation in BO3-3, PO4-3 and SO4-2 substituted CaMoO4:Dy3+ phosphors for application in White-Light LEDs Dr. AVULA, Balakrishna (University of Johannesburg)	
12:40 - 13:00	[343] Discussion of Improving the Physics in Indust		[135] Electron microscopy analysis of nanocrystalline diamond layers on zirlo Mr. NGONGO, Samkelo Sinoyolo (Nelson Mandela University)	
13:00 - 14:00	LUNCH			
14:00 - 16:00	ANNUAL GENERAL MEETING			

18:00 - 21:00	GALA DINNER

Mathematica

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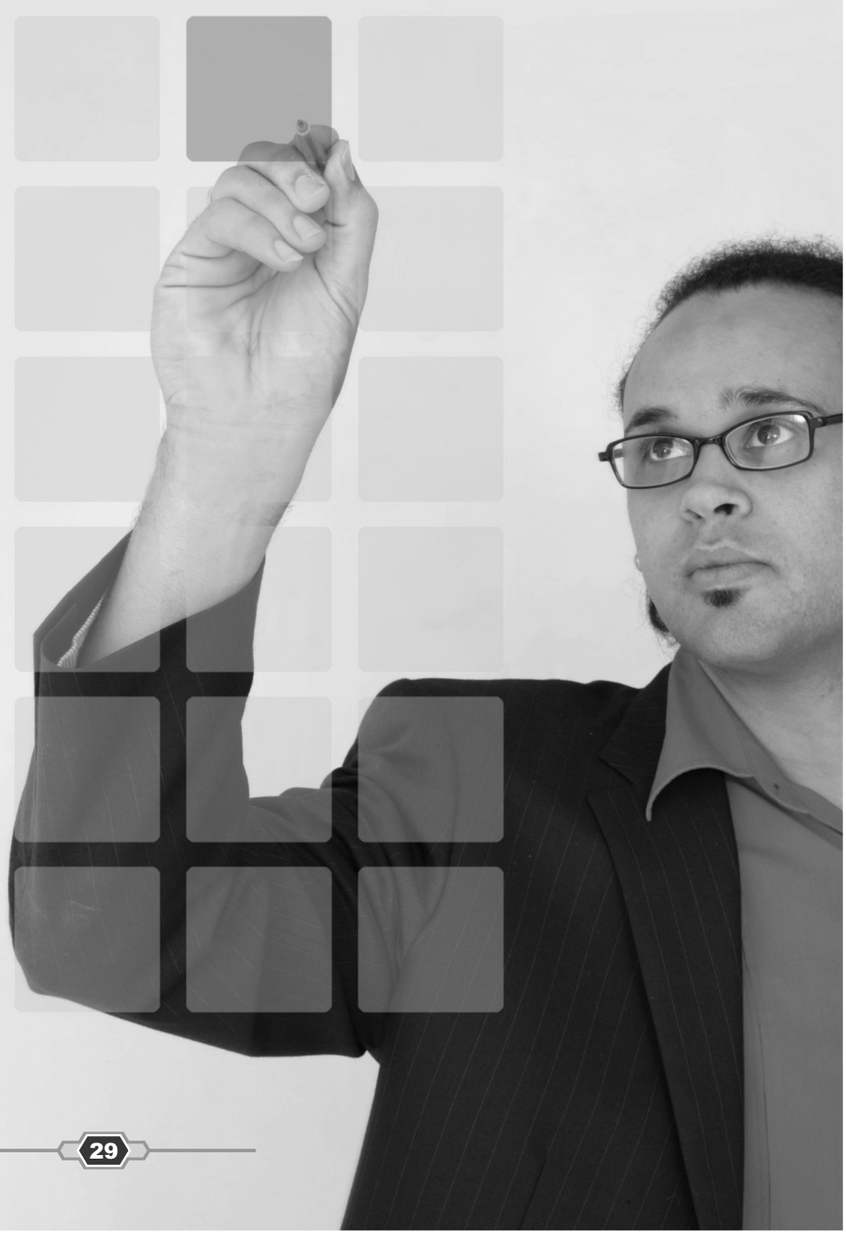

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POSTER SESSION 1 – TUESDAY 09 JULY (15:00 – 17:00)
POSTER SESSION 1: APPLIED PHYSICS AND NUCLEAR & PARTICLE PHYSICS DIVISIONS
Chairs: Dr Phil Ferrer; Prof Bruce Mellado, Dr Rudolph Nchodu
Venue: Makhulu

Board	Presenter	Title
1	Dr. VAN ROOY, Milton	[10] NMISA quality assurance through international comparisons of radioactivity measurements
2	Mr. LEPOTA, Thabo	[100] The development of a test station for the ATLAS Tile Calorimeter Low Voltage Power Supplies *[For award:* MSc*]*
3	Mr. SMALBERGER, Charl	[150] Experimental setup for optical observation of ultrasound-assisted cell manipulation *[For award:* MSc*]*
4	Ms. MAKHUVHA, Awelani Polite	[156] on the applicability of temperature based models for the estimation of global solar radiation on SAURAN weather stations *[For award:* Hons*]*
5	Dr. DIALE, Mmantsae	[159] Optimizing the organic Solar cell efficiency with the addition of dyes and nanoparticles.
6	Dr. AHMED, Ismaila Idowu	[311] Thermochemical Characterization And Suitability Of Animal Horns For Carbonitriding Treatment
7	Mr. SIVE, Magadla	[70] Microstructural characterization of Titanium to copper alloys with their antibacterial rate improvement for biomedical a pplication
8	Prof. MULABA-BAFUBIANDI, Antoine F.	[270] Optimization of convective heat transfer coefficients during “garification” process using Artificial Neural Network (ANN) Modeling
9	Mr. PENTZ, Rory	[88] Development and testing of a single photon detector for Quantum optics experiments
10	Mr. OSAYEMWENRE, Gilbert	[259] Electrical and mechanical degradation analysis of degraded single junction amorphous silicon solar modules
11	Dr. ZUMA, Siziwe	[257] The Socio economic analysis of the Ethiopian Government investing in the green economy through Biomass 2005 -2016 *[For award:* PostD*]*
12	Mr. NEKHWEVHA, Nditsheni	[80] Density functional theory study of optical and electronic properties of doped SnO2 with Ge and Sn. *[For award:* MSc*]*
13	Ms. MXAKAZA, Lineo	[174] Preparation of Cu2ZnSnS4/N-MWCNTs as potential Pt free counter electrodes in dye sensitized solar cells *[For award:* MSc*]*
14	Ms. TLHAOLE, Boitumelo	[230] Facile microwave hydrothermal synth esis of nickel sulphide- reduced graphene oxide composites *[For award:* MSc*]*
15	Mr. RANWAHA, Tshifhiwa Steven	[87] Density functional theory study of Cyanidin (Cy) dye molecule adsorbed on (100) TiO2 anatase surface for application in DSSCs *[For award:* MSc*]*
16	Mr. MAAKE, Tebogo	[232] Fire performance properties of South African commonly used hardwood *[For award:* MSc*]*
17	Dr. THANTSHA, Nicolas Dr. RORO, Kittessa	[233] Development of Tandem Perovskite Solar Cells
18	Ms. TLHAOLE, Boitumelo	[231] Microwave hydrothermal synthesis of nickel sulphide- reduced graphene oxide composites *[For award:* MSc*]*
19	Mr. NWODO, Julian	[186] Comprehensive Analysis of a Solar Measuring System and Response of Various Photovoltaic Modules and Systems *[For award:* MSc*]*
20	Dr. OVEREN, Ochuko Kelvin	[221] Daylight Availability & Energy Savings Potential in an Office Building in Alice
21	Mr. KWEMBUR, Isaac	[184] A case study on monitoring PID recovery on Multicrystalline modules *[For award:* PhD*]*
22	Mr. HLAKOLA, Mmatselagale	[185] Characterization of precision 1 Ω standard resistors due to environmental conditions and power loading
23	Dr. SIGAUKE, Caston	[282] Probabilistic forecasting of solar irradiance: An application to South African data
24	Mr. MHUNDWA, Russel	[166] Milk cooling energy optimization on a dairy farm through an energy audit approach
25	Mr. NEMAKHAVHANI, Thendo Emmanuel	[308] Low Dose Radiation damage in diamond *[For award:* PhD*]*
26	Mr. FHULUFHELO, Nemangwele	[303] Investigation of cave air ventilation and CO2 outgassing by radon-222
27	Ms. UMUHIRE, Marie Louise	[99] Influence of the atmospheric turbulence on a single photon source *[For award:* PhD*]*
28	Ms. MAHLANGU, Ntokozo	[243] The Performance and Degradation Analysis of different PV technology at different climatic regimes in South Africa *[For award:* MSc*]*
29	Mr. CHIKWELU, Edward Emenike	[264] Delineation Of Groundwater Contamination Using Electrical Method At Dump Site In Awka Urban Locality, Anambra State, Nigeria *[For award:* PhD*]*
30	Mr. VUMBUGWA, Monphias	[160] Effects of current mismatch due to uneven soiling on performance of mc-Si module strings *[For award:* MSc*]*
31	Ms. LEKALAKALA, Nthabiseng	[97] The Diagnostics and Verification System for the Tile Calorimeter Trigger and Data Acquisition framework of the ATLAS Detector *[For award:* MSc*]*
32	Mr. MAYIMELE, Meehleketo Advice	[163] Conductivity studies of Cu nanoparticles and dyes incorporated in both *[For award:* PhD*]*
33	Mr. WYNGAARD, Adrian	[201] Experimental and numerical study of EIT and FWM in an ensemble of cold rubidium atoms *[For award:* PhD*]*
34	Mr. MPILO, Dlamini	[57] A Review of Milli and Micro-flow Calibration Standards
35	Dr. MALUTA, Nnditshedzeni Eric	[299] Estimation of reference Evapotranspiration (ET0) using temperature data for Nwanedi area, Vhembe district Municipality, Limpopo Province, South Africa.
36	Mr. DIX-PEEK, Ross	[81] Temperature dependence of local breakdown voltages of crystalline Si S olar cells through voltage dependent ReBEL *[For award:* PhD*]*
37	Mr. TIKOLOGO, Otsile	[196] Monte-Carlo Shielding Calculations for a 10-MeV Electron Accelerator in Botswana *[For award:* MSc*]*
38	Dr. MIRA, Joele	[89] Production of metal ion beams with the iThemba LABS ECR ion source
39	Dr. SAKILDIEN, Muneer	[176] An Overview Of The Ithemba Labs Cyclotrons And Ion Sources
40	Dr. MUKERU, Bahati	[24] Study of total, complete and incomplete fusions
41	Ms. MTHEMBU, Sinegugu Happiness	[26] Angular correlation measurements with a segmented clover detector *[For award:* MSc*]*
42	Ms. KHUMALO, Charmane	[22] Low Pressure Focal Plane Detectors for the K600: A design study *[For award:* MSc*]*

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43	Dr. NEMULODI, fhumulani	[44] Beam intensity improvement of high energy heavy ions beams at iThemba LABS
44	Mr. CHIRUME, Witness	[45] Fluka Monte Carlo simulation of gamma photon transport through a distillation column, designed using ChemSep software *[For award:* MSc*]*
45	Mr. CHIRUME, Witness	[40] Investigation of the benzole prefractionator distillation column using gamma ray scanning technique *[For award:* MSc*]*
46	Dr. MADIBA, Itani Given	[323] Effect of neutron irradiation on the structural, electrical and optical properties evolution of RPLD VO films
47	Mr. ZIKHALI, Bonginkosi	[260] Internal conversion coefficients from conversion electron sources *[For award:* PhD*]*
48	Mr. MDLETSHE, Linda	[181] Search for collective structures in ^{186}Os *[For award:* PhD*]*
49	Mr. MNIKATHI, Ndumiso	[5] Beam emittance measurements in the SPC2 injection beamline at iThemba LABS*[For award:* MSc*]*
50	Mr. MAHESO, Abbey	[280] Design of a national indoor radon survey for South African Homes: review of existing indoor radon concentration data an d associated measurement techniques *[For award:* MSc*]*
51	Prof. MATHUTHU, Manny Ms. MOKHINE, Naomi D	[250] Developing Nuclear Forensics Signatures in the Southern African Region: A case study of South Africa and Namibia *[For award:* MSc*]*
52	Ms. PHEFO, LEBOGANG	[4] Determining the Radon Emanation Coefficient for soil sample. *[For award:* MSc*]*
53	Mr. EJEH, Ernest	[6] L-Shell X-Ray Production Cross Sections In 39y, 64gd And 83bi Induced By 0.1-2.0 Mev/U Heavy Ions [For Award: Phd]
54	Prof. CONNELL, Simon	[307] Geant4 in a new role – Reactor Physics
55	Mr. MASHISHI, Lehumo	[109] Fake lepton background estimation in $H \to Sh \to e^{\pm}\mu^{\mp} + $jets with ATLAS detector *[For award:* MSc*]*
56	Mr. MOTIMELE, KANTING	[226] The Description of Exclusive Proton-Proton Knockout Reactions from Unstable Nuclei Within a Relativistic Framework. *[For award:* MSc*]*
57	Mr. RAPHEEHA, Phuti Ntsoko	[104] Compatibility of a simplified BSM model with the observed excesses in multiple lepton production at the LHC *[For award:* MSc*]*
58	Mr. MAKUHANE, Sithole	[118] New Collective Structures in the Z = 76 Stable Odd Neutron Nucleus ^{187}Os. *[For award:* PhD*]*
59	Mr. MVELASE, Mashinga Johannes	[74] Radiological assessment in Weenen agricultural fields
60	Mr. DAVIS, Christopher	[32] Using Classification Based Neural Networks to Improve Missing Transverse Momentum Reconstruction from 13 TeV Proton -Proton Collisions *[For award:* N/A*]*
61	Mr. MASOK, FEILIX	[56] The Influence Of Phosphate Rock Storage On Gross Alpha And Gross Beta Activity Concentration Of Norm In Soil Samples From Richards Bay, South Africa
62	Dr. KAMUNDA, Caspah	[59] Toxicity of Natural Radioactivity in Water Samples from a Gold Mine in Gauteng Province, South Africa
63	Ms. SABATTA, Danielle	[116] Connecting the Muon g-2 with the Search for New Particles at the LHC *[For award:* MSc*]*
64	Mr. NKWASHU, Thabiso	[33] Electronic stopping force of 16O and 63Cu ions in Tantalum Nitride thin films by Time of Flight spectrometry *[For award:* MSc*]*
65	Ms. MOHLALA, Nthabiseng	[246] Radioactivity assessment of Uranium Isotopes concentration in water sources at and near selected former uranium mines in the West-Rand area of Johannesburg *[For award:* MSc*]*
66	Ms. TSEWU, Ayabulela	[50] From Radium to Radon: Radiological assessment of water sources around former uranium mines near West -Rand Johannesburg *[For award:* MSc*]*

POSTER SESSION 2 – THURSDAY 11 JULY (15:00 – 17:00)
POSTER SESSION 2: CONDENSED MATTER AND THEORETICAL PHYSICS DIVISIONS
Chairs: Dr Erasmus Rudolph; Prof Will Horowitz
Venue: Makhulu

Board	Presenter	Title
1	Dr. KALENGAY, Didier Mbela	[14] Structural and optical studies of tin iron chromium nano oxides
2	Mr. NYEMBE, Hlanganani	[151] Corrosion Resistance of TiZrN Coatings on ZIRLO Exposed to High-Temperature Oxygen*[For award:* MSc*]*
3	Mr. MTHWESI, zuko	[216] Effect of chemistry on the small punch creep properties of low carbon steels *[For award:* PhD*]*
4	Dr. JACOBS, Bincy Susan	[155] Effect of structural phase transition of GdCrO4 to GdCrO3 on magnetism
5	Ms. MOKOENA, Pulane	[195] Electrical properties of highly oxygenated silicon diodes for radiation detection applications; overview *[For award:* PhD*]*
6	Mr. NEMUTUDI, Bradley	[28] *Ab-initio* studies of sperrylite, platarsite and palladoarsenide phase stability and surfaces *[For award:* MSc*]*
7	Mr. MBOUKAM, Jean Jules	[218] Large magnetocaloric effect in RE2NiSi3 with RE = Dy and Tm *[For award:* PhD*]*
8	Mr. MOHAMMED, Hamza	[219] Structural stability and electronic properties of bulk, monolayer and bilayer PtX (X = Se and Te) *[For award:* PhD*]*
9	Ms. RAMASHITJA, Tshiwela caroline	[62] The Study of Microwave Power Effect and Anisotropic Effect in Ba0.34K0.64Fe2As2 (BaK122) Superconducting Single Crystal Using Non -Resonant Microwave Absorption Technique.
10	Ms. MNISI, Velile	[130] Investigation of beta Ti-Mo phase stability employing the first principle approach *[For award:* MSc*]*
11	Mr. NHLAPO, T. Amos	[274] Structural and magnetic characterization of Sm3+ ion substituted Zn-Mn nanoferrites synthesized by glycol-thermal method
12	Ms. RAMOSHABA, Moshibudi	[65] Equilibrium and electronic properties of cubic copper sulphide
13	Dr. LETHOLE, Ndanduleni Lesley	[66] First-principle studies on the structural, electronic an Mechanical properties of L10 FePt
14	Mr. MOLALA, Kgwajana Barnard	[69] Electronic and vibrational stability of M9S8 (M= Ir, Rh,) pentlandite-like structures: ab-initio study.*[For award:* MSc*]*
15	Mr. PHAAHLA, Tshegofatso Michael	[252] Geometry and Electronic Properties of TinPt (n = 2–7) Clusters: A Density Functional Theory Study *[For award:* PhD*]*
16	Mr. MKWAE, Prince	[83] Sythesis and Characterization of NiO thin films and nano-structures for gas sensing applications *[For award:* MSc*]*
17	Mr. BELE, ABONGILE	[175] The effect of iron-particles on the electrical properties of n-GaSb semiconductor material *[For award:* MSc*]*

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18	Ms. MKHONTO, Christine	[173] Alloy simulation of iron aluminides intermetallics *[For award:* MSc*]*
19	Ms. MOKOENA, Pulane	[172] Electrical properties of highly oxygenated silicon diodes. *[For award:* PhD*]*
20	Mr. DIX-PEEK, Ross	[84] Temperature dependence of local electroluminescence parameters of crystalline Si Solar cells *[For award:* PhD*]*
21	Ms. PHORI, Abigail	[25] Nanostructured 2D Ti3C2/NiO composite material as electrode for supercapacitors applications *[For award:* PhD*]*
22	Dr. LETSOALO, Thabo	[20] Computational Modelling of Minerals Sulfides
23	Mr. RUGUT, Elkana	[119] First principle studies on lattice thermal conductivity and thermoelectric properties of LiYSe 2 *[For award:* PhD*]*
24	Ms. SEGOLA, Ingrid	[42] Effects of spin parameters variation on the structural and optical properties of spin coated polyaniline thin films *[For award:* MSc*]*
25	Dr. OGUGUA, SIMON	[43] Luminescence and structural properties of Fe3+ doped ZnAl2O4: the influence of charge imbalance *[For award:* N/A*]*
26	Mr. FRU, Juvet Nche	[289] Stability of Methylammonium Lead Tri-bromide with Diffused Metal Electrodes *[For award:* PhD*]*
27	Mr. KHOELE, Joshua	[288] Study of structural damage in InGaN thin films due to Cu ion irradiation
28	Ms. MASENYA, Mamogo	[254] Growth of Silicon Carbide nanoparticles by thermal annealing of e-beam deposited SiC/Pd thin films on c-Si substrate
29	Dr. MBUYISA, Puleng	[189] Room temperature adsorption of ammonia gas on zinc oxide and zinc oxide–carbon nanostructures hybrid
30	Mr. NYARIGE, Justine	[285] Effect of temperature and concentration on hematite nanostructures prepared by chemical spray pyrolysis [For award: PhD]
31	Mr. KYESMEN, Pannan	[287] Structural and optical properties of hematite films prepared by spin coating at varying ramping rates [For award: PhD]
32	Ms. MALEKA, Prettier	[313] Computational modelling of TiO2/SnO2 interfaces for energy storage [For award: PhD]
33	Mr. RAMOGAYANA, Brian	[145] Computational investigation of Structural, Electronic, and Mechanical Properties of Spinel $LiMn^{2}O^{4}$ [For award: MSc]
34	Dr. NDLANGAMANDLA, Cebo	[300] Synthesis and Characterization of α-Fe2O3 nanorods arrays for Hydrogen Production
35	Dr. NEMANGWELE, Fhulufhelo	[301] The Effect Of Variable Microwave Power On The Low-field Absorption In Nano Nickel Added To Ybco Powder
36	Dr. MODIBA, Rosinah	[244] Effect of Co addition on the structural, electronic and magnetic properties of e16N2 employing first principles approach
37	Dr. JILI, Thulani	[247] Study of lattice defects in BaF2 using positron annihilation and X-ray diffraction methods at elevated temperatures
38	Ms. RATLHAGANE, Caroline	[267] Electrical characterization of n-type silicon diodes semiconductor material doped with tungsten particles. [For award: MSc]
39	Dr. FERRER, phil	[315] APPLIED PHYSICS AGM
40	Ms. MALIBE, Tshidi	[229] Exploration of intermediate phases that form during lithium and oxygen extraction from the Li2MnO3 nanoporous cathode material [For award: MSc]
41	Mr. SITHOLE, Thokozane Moses	[228] Effects of Gadolinium dopant on electrical characterization of p-type Silicon diodes [For award: PhD]
42	Ms. OSMAN JAFER, Tasabeeh Alabid	[165] Migration behavior of palladium implanted into glassy carbon [For award: PhD]
43	Mr. ABDELBAGI, Hesham Abdelbagi Ali	[167] Effect of swift heavy ion irradiation on the migration behavior of strontium implanted into polycrystalline SiC [For award: PhD]
44	Mr. MASHAMBA, Dakalo Dr. MSIMANGA, Mandla	[95] Heavy ion beam analysis of ion implanted poly-aniline nano-composites [For award: MSc]
45	Ms. MANAMELA, Mahlatse	[58] Hydrogen sulphide gas sensing behaviour of ZnO nanoparticles doped with cobalt and indium. [For award: MSc]
46	Mr. MAFA, Grant Tshepo	[31] Heavy ion beam induced sputtering of thin film TCOs at MeV energies. [For award: MASc]
47	Ms. MABIDI, P.M	[256] Magnetic and thermodynamic properties of the CeIrGa4 compound. [For award: MSc]
49	Mr. RATSHILUMELA STEV, dima	[298] Electronic and Optical Properties of Ru and Pt Doped TiO2 Brookite Surfaces Using Density Functional Theory [For award: PhD]
50	Mr. MAHONISI, Nyiku	[297] Fabrication of of NV centers in diamond [For award: MSc]
52	Prof. MOTLOUNG, Setumo Victor	[295] The effect of varying Cu2+ concentration on the structure and optical properties of BaAl2O4: x% Cu2+ ($0 \leqslant x \leqslant 1$) nano- phosphors prepared using the citrate sol-gel method
53	Dr. MEHLAPE, Mofuti	[292] Structural and Dynamical Properties of Pentlandite Nanostructures: Atomistic Simulation Approach.
54	Mr. TJEBANE, Tjatji	[293] Improving energy density in symmetric supercapacitors from optimized activated carbon using non-aqueous electrolytes [For award: PhD]
55	Ms. MOTAUNG, Gaopalelwe	[290] Cryogenic ion implantation of Polyethylene Terephthalate thin films: structural and electrical properties [For award: MSc]
56	Mr. DLAMINI, Clinton	[125] Effect of annealing temperature on the structure, morphology and luminescence properties of mixed phases SrAl2O4/Sr3Al2O6/SrCO3:0.05% Gd^{3}υ· nanopowders prepared by citrate sol-gel method [For award: MSc]
57	Mr. SEKGA, Comfort	[215] Quantum secret sharing with graph states [For award: PhD]
58	Mrs. ELEGBELEYE, Ife Fortunate	[208] Density Functional theory study of optical and electronic properties of (TiO2)n=5,8,68 clusters for application in organic and hybrid organic-inorganic solar cells [For award: PhD]
59	Ms. ADAMS, Betony	[188] Quantum effects in the brain: a review of possible mechanisms
60	Mr. MAGABE, Audrey Thabang	[203] Comparative study of machine learning techniques in the search for dark matter candidates associated with missing transverse energy [For award: MSc]
61	Ms. BALOYI, Nkateko	[113] Discrimination of Signal-Background events with Supervised and Semi-Supervised Machine Learning in the search for bosons decaying to Z + γ final state *[For award:* MSc*]*
62	Mr. MAKGOBA, Malesela Walter	[64] Structural stability of some graphene oxide formations *[For award:* MSc*]*
63	Dr. AKANDE, Amos	[90] Title: Facile sensing characteristics of V2O5 nanostructured electrode from experimental and first principle approach.
65	Mr. KEKANA, Magopa Tshepho Mcdonald	[75] Point defects in cubic Boron Nitride(c-BN) *[For award:* Hons*]*
66	Mr. SAMUKONGA, Gilbert	[53] Super-Hard Materials of the B-C binary system *[For award:* PhD*]*
67	Ms. NDOU, Susan	[73] Water Adsorption On Ptas2 (111) Surface: A General Picture From Density Functional Theories *[For award:* Hons*]*
68	BARDE, Abdu	[154] Structural, electronic and optical properties of rare-earth copper chalcogenides LaCuX (X = S, Se): A first principles study *[For award:* PhD*]*

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Astrophysics / 1

Astrophysical Transients with MeerKAT and MeerLICHT

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In July 2018, MeerKAT was inaugurated and started its science mission. One of the 5-year legacy programs on MeerKAT is the ThunderKAT large survey project which aims to find, identify and understand high energy astrophysical processes via their radio emission. This is achieved through a program of surveying and monitoring Galactic synchrotron transients (X-ray binaries, Cataclysmic variables, Supernova and Gamma-ray bursts). Out of the ThunderKAT collaboration emerged a novel concept of real-time simultaneous radio and optical monitoring of the MeerKAT sky to fully characterise radio transients discovered in the data stream. Thus a new optical wide field telescope (MeerLICHT) was funded and constructed, and inaugurated in Sutherland in May 2018. MeerLICHT will provide simultaneous night time optical data for all MeerKAT pointings. In this presentation we will give an overview of some of the first scientific results from MeerKAT and MeerLICHT related to astrophysical transients.

Theoretical and Computational Physics / 3

The Equation of State of weak hadron gas from microscopic model

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The Equation of State (EoS) of a hot and dense hadron matter is studied using a microscopic transport model which can support the Large Hadron Collider energies of up to √(s_nn)= 14 TeV, namely the Ultra-relativistic Quantum Molecular Dynamics (UrQMD). The molecular dynamics simulation is performed for a system of light meson species (π; ρ; K) in a box with periodic boundary conditions. The equilibrium state is investigated by studying the chemical equilibrium and the thermal equilibrium of the system. The particle multiplicity equilibrates with time, and the energy spectra of different light meson species have the same slopes and common temperatures when thermal equilibrium is reached. The solution of the EoS allows for better understanding of the final state of interactions, which is dominated by hadrons produced during ultra-relativistic heavy ion collisions.

Poster Session 1 / 4

Determining the Radon Emanation Coefficient for soil sample.

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Radon and radon decay products have been known to cause lung cancer in
humans, and hence a national survey to measure radon levels in houses in
South Africa is underway. This study is a preliminary to the national survey to be conducted and it aims to determine the radon emanation coefficient for soil samples. The radon emanation coefficient is important for predicting the radon levels in the houses. The areas of interest in this study are (Paarl and Boksburg) where high radon levels are expected and the soil samples have been collected and will be analysed in the laboratory. Measurement techniques including both alpha and gamma spectrometry will be utilized for determining the activity of the soil samples in order to determine the radon emanation coefficient.

Poster Session 1 / 5

Beam emittance measurements in the SPC2 injection beamline at iThemba LABS

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iThemba LABS provides accelerator and ancillary facilities for research and training in physical, biomedical and material sciences. At the heart of the iThemba LABS accelerator complex is the variable-energy, separated-sector cyclotron. A solid-pole injector cyclotron SPC2 is used for pre-acceleration of light and heavy ions which has overall transmission of approximately 10%. In order to improve transmission, several ideas are currently being investigated
through simulation studies. The success of these studies depends on the knowledge of the emittance from the ion sources. At present, there is no system that measures emittance in the beamline which leads that simulations are performed with estimated values for the beam emittances. This could lead to undesirable results, hence, the accurate measurement of beam emittance is required. This project aims at developing a method that can be used to accurately measure
beam emittance in the injection beamline. In this talk, the progress made thus far will be presented.

Poster Session 1 / 6

L-SHELL X-RAY PRODUCTION CROSS SECTIONS IN 39Y, 64GD AND 83BI INDUCED BY 0.1-2.0 MEV/U HEAVY IONS

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The availability of accurate and reliable heavy ion-matter interaction database is very crucial for the utilization of different heavy ion beam analytical techniques such as heavy Particle Induced X-ray Emission, heavy ion Elastic Recoil Detection Analysis (ERDA), etc. It is, therefore, expedient to expand the existing global database of basic ion-atom interaction phenomena by adding new experimental data of heavy ion induced X-ray production cross sections in elemental films.

In this work, the production cross sections of L-shell X-rays of some rare earth elements induced by 12C, 35Cl, and 64Cu ions were measured in the energy range of 0.2-1.0MeV/u. The experimental results were compared with ECPSSR and PWBA predictions. Agreements and discrepancies between theory and experimental data are discussed in terms of how theory describes different ionization mechanisms at play during ion-atom collisions

Theoretical and Computational Physics / 9

Calculation of the Higgs mass in GHU: SU(3)W × SU(3)C

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We discuss the computation of the Coleman Weinberg effective potential in an SU(3)W × SU(3)C gauge Higgs model in five dimensions. We attempt to compute the Higgs mass in this model, where we had previously calculated the unification of the gauge and top-like Yukawa couplings.

Poster Session 1 / 10

NMISA quality assurance through international comparisons of radioactivity measurements

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The National Metrology Institute of South Africa (NMISA) Radioactivity Standards laboratory maintains the standard for radioactivity in South Africa. The nuclear industry requires dissemination of high accuracy, low uncertainty calibration standards. Where the quality of life of the public is of concern, the accuracy of various instruments used to measure radioactivity is extremely important. Through primary measurements, high accuracy, low uncertainty calibration standards are produced, which can be used to calibrate HPGe detectors for environmental measurements of radioactivity. The NMISA secondary standard ionisation chamber is also calibrated to measure nuclear medicine and calibration factors can be determined for hospital and isotope production facilities ionisation chambers. Through participation in international comparisons of radioactivity measurements using primary measurement methods, we ensure the quality of our results and demonstrate equivalence with international metrology institutes. Our primary measurement methods are described and successful participation in more than 40 international comparisons is discussed.

Astrophysics / 11

Theoretical modelling of a new class of anisotropic compact stellar model compatible with observational data

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In this paper, a physically motivated form of one of the metric potential and a specific choice of the anisotropy has been utilized to obtain closed-form solutions of the Einstein field equation for a spherically symmetric anisotropic matter distribution. This class of solution has been used to develop viable models for observed pulsars. The exterior spacetime is assumed as described by the exterior Schwarzschild solution. The model parameters have been determined from the smooth matching of the interior to the exterior Schwarzschild spacetime metric and utilizing the condition that radial pressure is zero across the boundary. The physical acceptability of the developed model has been examined in detail by making use of the current estimated mass and radius of a known pulsar namely, 4U1820 – 30. The gross physical nature of the observed pulsar has been analyzed graphically. The stability of the model is also discussed given causality conditions, adiabatic index and under the forces acting on the system. To show that this model is compatible with observational data, few more pulsars have been considered, and all the requirements of a realistic star are highlighted. Also, the mass-radius (M – R) relationship of compact stellar objects analyzed.

Theoretical and Computational Physics / 13

A non-minimal composite Higgs model

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Composite Higgs studies, where the Higgs boson emerges as a pseudo-Nambu-Goldstone boson after the breaking of the global symmetry group, present a BSM solution to issues such as the hierarchy problem. In such models, the Higgs is described as a bound state of a confining "strong" force. Here, we investigate the phenomenology of a model with a non-minimal group structure, where the Yukawa couplings are generated through the partial compositeness mechanism. This leads to a spectrum of composite fermion partners, the lightest of which is the top partner.

Poster Session 2 / 14

Structural and optical studies of tin iron chromium nano oxides

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In the present study, we have synthesized Sn0.2Fe0.9Cr0.9O3 nano oxides. Single phase corundum -like structure and nanophase structure of the as-synthesized sample were confirmed by X-ray diffraction (XRD) and by transmission electron microscope (TEM). The results show that the produced powders have grain size of approximately 32 nm. Using the result of the UV-Vis spectrometer, we were able to determine the energy band gaps of 3.1 and 5.2 eV, when nanoparticles diluted in iron standard and in deionised water respectively.

Physics of Condensed Matter and Materials / 15

Structural, Mössbauer, magnetic and optical studies of Sn0.2FexCr1.8−xO3 nano oxides prepared by reflux and pressure reactor methods

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We have investigated the properties of Sn0.2FexCr1.8−xO3 synthesized directly from high purity metal by reflux and by pressure reactor process. These alloys series were synthesized at low reaction temperature of about 100 ℃ using hydrothermal methods. XRD analysis for the samples synthesized in a stirred pressure reactor and in a reflux indicate the basic corundum structure for the compositions after annealing at 600 ℃. TEM experiment indicate a similar trend for both methods of preparation with a particle size for samples prepared in a pressure reactor slightly reduced compared to that synthesized in a reflux. No appreciable difference was observed on the magnetic properties of the two sets of samples. Particle sizes and chemical disorder are shown to play critical roles in influencing the properties of the nanomaterials. The 57Fe Mössbauer spectra measured at room temperature are well fitted by two magnetic components that range from two sextets for Fe-rich nanomaterials to two doublets for Cr-rich ones.

Space Science / 16

Onset of 2D magnetic reconnection in the solar photosphere, chromosphere and corona

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2D reconnection is studied numerically in the context of various atmospheric layers in the Sun: the fully ionized coronal plasma; the partially ionized chromospheric plasma; the almost-neutral photospheric plasma. Numerical simulations solve the compressible, resistive magnetohydrodynamic equations, with reconnection triggered by driving external flows perpendicularly towards an equilibrium Harris current sheet. The inflow velocity controls the rate of flux entering the reconnection region. In the corona the electric field rises sharply (indicative of reconnection) for a range of velocity drivers. In the photosphere reconnection occurs only when the inflow approaches the local Alfven velocity. Ambipolar diffusion alters the structure of the current density in the chromosphere.

Space Science / 17

Observations of a kink-unstable coronal loop using DKIST/DL-NIRSP and Hinode/EIS

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A 3D non-eruptive kink-unstable coronal flux rope is simulated by solving numerically the nonlinear magnetohydrodynamic equations with parallel thermal conduction. The time evolution from the initial unstable equilibrium is forward modelled by generating synthetic spectral intensity maps as observed by DKIST/DL-NIRSP and Hinode/EIS using the CHIANTI database. The predicted signatures of the new ground-based Daniel K Inouye Solar Telescope (DKIST) in the coronal off-limb mode of its Diffraction Limited Near Infrared Spectropolarimeter (DL-NIRSP) instrument are compared and contrasted with signatures from the Hinode satellite's EUV Imaging Spectrometer (EIS). The reconstructed observations show detailed, fine-scale structure and exhibit signatures of wave propagation, redistribution of heat, flows, and fine-scale bursts.

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The solar wind during C22-C23 and C23-C24 solar minima

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The solar minima between cycles 22-23 and 23-24 were unusually long and quiescent, creating ideal time windows to study the undisturbed solar wind. In situ measurements of the solar wind magnetic field, velocity, and helium and proton number densities are obtained from the ACE and WIND satellites at a cadence of one hour. A wavelet analysis shows the synodic equatorial rotation signal with higher frequencies due to the presence of coronal holes. Fourier spectra of the separated fast and slow wind components capture a fundamental oscillation of typically 5.6 microhertz plus its associated overtones. Autocorrelations support the wavelet results, polynomial approximations give overall trends, and the magnetic and velocity vector fields are used to extract information from the data.

Applied Physics / 19

Nanocrystalline Silicon Devices for Radiation Sensing Applications

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Nanocrystalline silicon detectors show radiation sensing at a faster response and high ratios of photo detectivity which are qualities that are desired for radiation detection. In this research, nanocrystalline silicon was grown and characterized to determine its structural, morphological and elemental composition. A comprehensive review of the temperature dependence of current-voltage (I-V) measurements that were carried out on Schottky diodes fabricated on undoped and niobium-doped n-type nanocrystalline silicon. The I-V measurements were carried out within a temperature range of 20K to 360K. Additionally, investigations were done on the temperature dependence of the saturation current, the Schottky barrier height and the ideality factor. The results of this work are in agreement with those reported on the existing literature. Niobium induces deep defect levels within the mid gap of nanocrystalline silicon material to act as generation-recombination centers. The defects compensate charge carriers to turn the nanocrystalline silicon into relaxation material. Radiation detectors fabricated from relaxation materials are characterized by ohmic behavior and high resistivity due to recombination of charge carrier by the midgap levels. Thus, the device can be used as a radiation- hard detector in a high energy physics experiments.

Poster Session 2 / 20

Computational Modelling of Minerals Sulfides

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There are several computational techniques and experimental studied minerals sulfides. Group of sulfides in nature and significant importance because they serve as a source of economic for many applications. We used parameterization technique to study chalcopyrite, pyrite, marcasite and sulfides minerals structures using a Density Functional based Tight-Binding (DFTB+). We developed sets of parameters for $FeCuS_2$, MnS_2, FeS_2, CoS_2, NiS_2, CuS_2 and ZnS_2 mineral compounds. However, S-S interaction pairs produced some good bond lengths, lattice parameters, bulk modulus and elastic constant of minerals sulfides and gave a good agreement of computational-based calculations and experimental results. Density of states (DOS) and band structures chalcopyrite ($FeCuS_2$) DFTB+ calculations compare with other results showed that there is no bang gap. Cluster Expansion showed alloyed pyrite with Oxygen are stable phases increased band gap and Monte Carlo indicates that the is no phase transition at all different temperature but for photovoltaic applications of fabricating pyrite absorber because there is promise with optimum band gap.

Astrophysics / 21

Multi-messenger hunts for heavy WIMPs

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The gold-standard of astronomical WIMP hunting has historically been the ability to detect dark matter annihilation signals at thermal relic cross-section required to produce the observed cosmological dark matter abundance. A model's status becomes dubious if expected emissions are not observed at this point, as a weaker cross-section implies this candidate would not supply the bulk of cosmological dark matter. A persistent challenge in this field has been in reaching this level of sensitivity when probing models that feature a WIMP mass above 1 TeV. In this talk we discuss recent advances in neutrino astronomy that provide new tools to explore the largely uncharted realm of heavy WIMPs.

Poster Session 1 / 22

Low Pressure Focal Plane Detectors for the K600: A design study

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Magnetic spectrometers have proven to be very useful in the world of experimental nuclear and astrophysics. The focal plane detection system instrumenting these spectrometers is instrumental in their success. A new focal plane detection system is envisaged for the K600 QDD magnetic spectrometer at iThemba LABS in Cape Town, South Africa. The existing focal plane detection system, consisting of two multi-wire drift chambers (MWDCs) and plastic scintillators, is designed to detect light ions (H and He isotopes) at medium energies (50-200 MeV). The significant material budget of these detectors affects the low energy threshold for operation of the K600. A conceptual design for a new focal plane detectionsystem will be presented.

This work is sponsored by the NRF

Poster Session 1 / 24

Study of total, complete and incomplete fusions

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We present a theoretical study of total, complete and incomplete fusion. Using the different fusion definitions and considering the angular distributions total fusion cross section, it is shown that there is a lower angular momentum L, such that below this value, the total fusion is independent of the projectile binding energy. We show that this region represents the complete fusion.

Poster Session 2 / 25

Nanostructured 2D Ti3C2/NiO composite material as electrode for supercapacitors applications

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Cost-effectiveness and environmentally friendly nature of the transition metal oxides are some motivating factors for their exploration for use as energy storage devices applications when compared to other electrode materials. This work reports the successful synthesis of Ti3C2/NiO nanocomposite for application as supercapacitor electrodes. The as-synthesized material was characterized by various techniques such as, Raman spectroscopy, BET, SEM, TEM and XRD to ascertain the morphological and structural nature of the material. Electrochemical characterization of the composite material performed in a three-electrode configuration using 6 M KOH electrolyte reveals high specific capacity and excellent cycling stability with satisfactory capacity retention for over 2000 cycle.

Poster Session 1 / 26

Angular correlation measurements with a segmented clover detector

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Gamma-gamma angular correlation measurements are an important tool to determine (i) the spin and parity of a nuclear state (ii) the multipolarity and the multipole mixing ratio of a gamma-ray transition. A segmented clover detector was placed at close geometry and tested it for angular correlation measurements using ^{133}Ba and ^{60}Co sources. The segments of the clover were used as individual detectors. This allowed one to determine the angular correlation coefficients, a_2 and a_4, and to determine the multipole mixing ratios of several gamma-ray transitions. Codes to sort and analyze gamma-gamma angular correlation data were developed and a technique to deduce the multipole mixing ratios was established. The angular correlation technique developed for the iThemba LABS segments clover detector allowed the determination of several multipole mixing ratios with high precision and new results on the signs of the multipole mixing ratios for some transitions in ^{133}Ba were obtained. The analysis of the $1173 - 1332$ keV cascade in ^{60}Co showed that using the segmented clover one can easily distinguish a stretched dipole from an unstretched quadrupole transition.

Astrophysics / 27

Costraining f(R)-gravity with cosmological data

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We are looking at how to constrain E(R)-modified gravity models, such as E(R) =βRn (a toy model) or more realistic E(R)-gravity models like the Starobinsky or Hu-Sawicki model, to cosmological data. We used 236 intermediate redshift and 123 low redshift Type 1A Supernovae data obtained from the SDSS-II/SNLS3 Joint Light-curve Analysis (JLA), with absolute magnitudes for the B-filter found on the NASA Extragalactic Database (NED). We then developed a Monte-Carlo Markov Chain (MCMC)-simulation to find the best fit (firstly to the ΛCDM model) to obtain the cosmological parameters (Ωm and ħ). We then used the concordance model results to constrain the priors for the E(R)-gravity models on the MCMC-simulation. We assumed a flat Universe Ωk = 0 and a radiation density Ωr that is negligible in both the ΛCDM model and E(R) -gravity models. Thus, the only difference between the ΛCDM model and E(R)-gravity models, will be Dark Energy and arbitrary free parameters. This will tell us if there exist viable E(R)-gravity models, when we compare them to the results of the ΛCDM model and thus, constraining the generic E(R)-gravity models with cosmological data.

Poster Session 2 / 28

Ab-initio studies of sperrylite, platarsite and palladoarsenide phase stability and surfaces

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Computational modelling studies of platinum group minerals (PGM): sperrylite ($PtAs_2$), platarsite (PtAsS) and palladoarsenide (Pd_2As), were carried out to investigatate their stabilities and surfaces. These are paramount to the mining industry in South Africa as they are the most extracted minerals in the Platreef bushveld complex. In this study we employed the Vienna *Ab-initio* Simulation Package (VASP) along with the projector augmented wave (PAW) method to investigate the structural stability and surface stabilities of $PtAs_2$, PtAsS and Pd_2As. In addition, the phase stability of PtAsS was investigated using cluster expansion, while the $PtAs_2$ and Pd_2As were obtained from phonon dispersions. We found that the calculated lattice parameters of the studied structures are in good agreement with the experimental data. The PtAsS cluster expansion showed that all generated structures are thermodynamically stable and the phonon showed no soft modes for $PtAs_2$, PtAsS and Pd_2As structures. The calculated surface energies indicated that the (100) surface for $PtAs_2$, PtAsS and Pd_2As was the most stable amongst the low miller index (100), (110) and (111) surfaces. As such the (100) surface was considered as the working surface for all the surface models. The order of surface energies followed as: (100) < (111) < (110) for $PtAs_2$ and PtAsS and (100) < (110) < (111) for Pd_2As. The calculated thermodynamical equilibrium morphologies of the relaxed surface structures indicated that (100) surface was the most dominate surface for all the studied surface structures. These findings gave more insights on the stability of these minerals and their surface stabilities which may be applicable in their recovery.

Theoretical and Computational Physics / 29

Transport coefficients of relativistic fluids from third order causal theory

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Third order non-equilibrium fluid dynamics as an extension of Muller-Israel-Stewart theory for dissipative relativistic fluids have been derived using Grad's 14-moments techniques. We have tried to calculate transport coeffcients for shear, bulk pressures and heat flow as well as pressure anisotropy for relativistic dissipative fluids.

Applied Physics / 30

DENSITY FUNCTIONAL THEORY STUDY OF COPPER ZINC TIN SULPHIDE (Cu2ZnSnS4) DOPED WITH CALCIUM AND BARIUM

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The sun is the most important source of renewable energy today. Producing energy from sunlight using cheap, abundant and non-toxic materials is considered a major challenge in the field of solar-electrical energy conversion. To harvest the solar energy, a thin film solar cell composed of the Cu2ZnSnS4 (CZTS) semiconductor is a candidate which can harvest as much energy as possible. Its advantage is the optical direct band gap and high absorption coefficients. The structural, electronic and optical properties of doped CZTS will be calculated using the density functional theory (DFT) as implemented in the CASTEP codes. A new doping mechanism will be used to dope by the alkali earth metals, Calcium (Ca) and Barium (Ba). The dopants will be placed in the structure rather than replacing one of the atoms. Doping using the different elements is expected to improve the conversion efficiency of the CZTS based solar cells.

Poster Session 2 / 31

Heavy ion beam induced sputtering of thin film TCOs at MeV energies.

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Heavy ions in Ion Beam Analysis techniques (IBA) such as MeV SIMS are sometimes limited in their application due to lack of experimental fundamental ion-atom interaction data. We report on an investigation carried out to measure heavy ion beam sputtering yields due to irradiation and irradiation effects on physical properties of Transparent Conducting Oxides (TCOs) at MeV energies. Measurements were carried out using the Heavy Ion Elastic Recoil Detection Analysis (ERDA) and Rutherford Backscattering (RBS) techniques to determine electronic sputtering yields in Indium Tin Oxide and Zinc Oxide films due to Si and Cu beams of MeV energies. Results of measurements are discussed in the context of possible applications in MeV SIMS analysis.

Poster Session 1 / 32

Using Classification Based Neural Networks to Improve Missing Transverse Momentum Reconstruction from 13 TeV Proton-Proton Collisions

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Missing transverse momentum is a difficult variable to reconstruct from 13 TeV proton-proton collisions. Regression based neural networks can be used to reconstruct missing transverse momentum , however, these neural networks display a bias: they have difficulty distinguishing between events with relatively small true missing transverse momentum over events with zero true missing transverse momentum. I will detail progress towards a method to remove this bias involving construction and training of a classification based neural network to distinguish between events that have true missing transverse momentum and events that have no true missing transverse momentum, and only passing events that have missing transverse momentum to the regression based neural network for missing transverse momentum reconstruction.

Poster Session 1 / 33

Electronic stopping force of 16O and 63Cu ions in Tantalum Nitride thin films by Time of Flight spectrometry

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The study of the passage of energetic ions in matter is of interest for our understanding of basic ion-matter interactions and for applications in ion beam based technologies such as Ion Beam Materials Analysis, Ion Implantation, Radiation Detection and Measurement, and so on. The provision of experimental stopping force data is crucial for the continual validation of predictive theoretical models and semi-empirical codes. The work presented here describes the measurement of energy loss of heavy ions (O and Cu) through thin metallic films (TaN) using a Time of Flight – Energy spectrometer (ToF-E). Energy loss measurements are then used to calculate the stopping force. It is shown from the results, that the experimental and theoretical stopping force show the same trend of variation with energy, although there is a clear discrepancy between the experimental and theoretical data. The difference between the experimental results and theory is explained in terms of possible heavy ion induced second order effects in ion-atom interactions

Astrophysics / 34

Mira Variables and the Extragalactic Distance Scale

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Infrared observations of newly-discovered Mira variables in Local Group galaxies have shown that they follow a tight period-luminosity relation that can be used to determine a distance to any nearby galaxy found to harbour such stars. This
presentation will show the outcome of a campaign with the IRSF telescope at Sutherland and consider the implications of the result for the distance scale in the era of the James Webb Space Telescope due to be launched in the near future.

Space Science / 35

Fast ion-acoustic soliton stopbands in plasmas with two-temperature kappa-distributed electrons

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The existence of stopbands, which are ranges in speed where solitons
cannot propagate was proposed for the very first time in a study of fast ion-acoustic solitons by Nsengiyumva *et al.* [1] for a plasma composed of cold ions, warm (adiabatic) ions and Boltzmann electrons. We recall that the stopbands arise when the warm ion limiting curve is double-valued in speed over a range of normalised cold ion density values. The current study is a theoretical investigation of stopbands in a plasma with cold ions, warm (adiabatic) ions and two-temperature kappa-distributed electrons, having spectral indices κ_c and κ_h. The stopbands are found to widen for decreasing values of κ_c (κ_h is fixed) or κ_h (κ_c is fixed), until the warm ion limiting curve bifurcates into an upper and lower branch. The stopbands disappear when the warm ion limiting curve becomes single-valued over the range of cold ion densities for very low values of the spectral index, when the proportion of superthermal electrons is significant. The considered plasma model may be applied to the magnetosphere of Saturn [2] where two-temperature electron populations which follow kappa distributions exist.

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Nuclear, Particle and Radiation Physics / 36

Simulation of the ATLAS ITk Strip Endcap Modules for Testbeam Reconstruction and Analysis

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The Large Hadron Collider (LHC) is planned to be upgraded to the High Luminosity LHC (HL-LHC), which will increase the number of particles passing through the detectors. This will require the detectors to be upgraded in order to cope with the large increase in data collection and radiation as well as improving the tracking and particle reconstruction in the higher occupancy environment. A major upgrade to the ATLAS detector will be replacing the current Inner Detector (ID) with a fully silicon semiconductor based Inner Tracker (ITk). The sensors in the ITk strip forward region will use radial geometries, however the current testbeam simulation and reconstruction packages are designed with cartesian geometries. Presented is the work behind implementing a radial geometry and charge propagation for one of the ITk strip forward sensors, the R0 module, in these testbeam software packages. The data from the EUDET testbeam telescope at DESY, Hamburg, and the simulated data both undergo the same reconstruction and a comparison between the two is then performed.

Theoretical and Computational Physics / 37

Fluctuating Open Heavy Flavour Energy Loss in a Strongly Coupled Plasma with observables from RHIC and the LHC

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Heavy ion collisions at RHIC and at the LHC produce an enormous amount of energy that enables the nuclei and its constituent particles to melt, thus releasing gluons, quarks and antiquarks, travelling in different directions with different momenta. Studies of these collisions have shown that low transverse momentum observables describe a strongly coupled plasma (quark-gluon plasma), an almost perfect liquid that evolves hydrodynamically and flows with almost no viscosity. We make predictions for the suppression of the heavy flavor mesons that these heavy quarks decay to and thus describe the energy loss of these heavy quarks as they interact with the plasma; we show that these predictions are in good agreement with experimental data.

Physics of Condensed Matter and Materials / 38

Structural, thermodynamic, electronic and mechanical properties of MCO_3 (M: Ca, Mn, Fe, Co, Ni) precursor materials for Li-ion batteries

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First-principles calculations were carried out on the structural, thermodynamic, electronic and mechanical properties of MCO_3 precursor materials at 0 K to investigate their possible application as cathodes in Li-ion batteries. Li-ion batteries are the most crucial power sources for portable electronic devices. However, their performance greatly depends on the cathode materials, which serves as a host structure for Li ions. We have employed the plane-wave pseudopotential method framed within the density functional theory (DFT) as implemented in the VASP code. The structural lattice parameters were calculated to 95% agreement with the experimental data, ensuring robustness of the approach employed. The calculated heats of formation are relatively low, suggesting thermodynamic stability. The electronic density of states showed that $CaCO_3$ and $MnCO_3$ are insulators, whereas $CoCO_3$ and $NiCO_3$ are semiconductors. Interestingly $FeCO_3$ is predicted to be metallic, suggesting good electric conductivity. The phonon dispersion curves showed negative vibrations in all MCO_3 systems, suggesting mechanical instability.

Nuclear, Particle and Radiation Physics / 39

Understanding the J/Psi background in top quark events using proton-proton collision data at a centre-of-mass energy of 13 TeV in ATLAS

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High precision measurements of the top quark mass have been widely sought after since the discovery of the top quark. This mass is correlated with the top quark's decay products and the best current measurements are predominantly limited by uncertainties related to the reconstruction of jets. However, there are top quark decay signatures which are largely independent of the aforementioned uncertainty but require large amounts of data as they are produced at a much lower rate than the usual signatures. One of these decay signatures include a J/Psi meson originating from a B-hadron. The ATLAS detector cannot identify the exact origin of these J/Psi mesons and therefore, background J/Psi mesons contribute and negatively impact the mass measurement. However, these background J/Psi contributions can be separated from signal J/Psi mesons by exploiting the mass of a J/Psi meson and the unique displaced decay vertex feature of B-hadrons. This paper describes a data-driven technique to determine the contributions from signal and background J/Psi mesons and highlight kinematic regions which limit the contamination of background J/Psi mesons in preparation for the large dataset that will be available at the end of the next data-taking period.

Poster Session 1 / 40

Investigation of the benzole prefractionator distillation column using gamma ray scanning technique

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Gamma column scanning technique was used to scan and investigate the integrity of the 26m tall benzole prefractionator column consisting of 60 single pass trays and a diameter of 0.8m. A 100mCi Cobalt 60 gamma radiation source and NaI scintillation detector was used to scan the distillation column. The obtained results were presented in a graphical form of column elevation against intensity. The results showed that all the trays were in their correct position but at tray number 32 the profile showed that it could be partially damaged and also just below tray 41 the scan revealed that there is loss of thickness on the column wall. The obtained density profile showed some small variations from the expected density profile and this was attributed by external features on the distillation column.

KEYWORDS
gamma ray scanning, density profile,Cobalt 60 gamma radiation source

Astrophysics / 41

Astronomical opportunities for HBU's

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More than two decades after the birth of South Africa's democracy we find ourselves in an exciting era for astronomy in South Africa. The MeerKAT and SALT telescopes are producing world class science, the number of astronomers in the country are steadily growing, government funding is significant, and hundreds of students are finding opportunities within the broad scientific and technical disciplines associated with flagship astronomy projects. However, there is still a clear gap between those universities that are active beneficiaries of South Africa's investment in astronomy, and the many other universities in the country. At a glance it is evident that South Africa's Historically Black Universities (HBUs) have not reaped large benefit from the astronomy field. Partly due to the pressing need for transformation within the astronomy field, students from Physics Departments at HBUs often feed into human capital development programmes, taking potential skills away from their home institutions. There is thus a clear need to build stronger partnerships between the astronomy community and South Africa's HBUs, both in order to more effectively transform the demographics of the field, and to build scientific human capacity that remains at and benefits those institutions. The Office of Astronomy for Development (OAD) has been working with the University of Zululand for several years to explore how astronomy could bring benefit to the university, primarily through the Physics Department. Initiatives include capacity development workshops; small telescope, robotic telescope and Virtual Observatory training; astronomy outreach; and the potential development of new telescope site which would have a combined research, training and community development purpose. The long term perspective is that such initiatives can be replicated in HBUs in South Africa and universities across the African continent, where there may be active Physics departments, but minimal astronomy activities.

Poster Session 2 / 42

Effects of spin parameters variation on the structural and optical properties of spin coated polyaniline thin films

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In this study, polyaniline thin films of various thicknesses on a silicon (Si) substrate were deposited by electrospinning polyaniline-emeraldine base (PANI (EB)) solution obtained by mixing PANI with the solvent DMSO (Di-methyl sulphur dioxide). Different thicknesses of the films were obtained by varying the spin coating time, while uniformity was investigated by varying spin coating speed. The constant flow of the solution was maintained at all times, resulting in the constant dropping of the solution on the substrate. Rutherford backscattering spectrometry (RBS) was used to determine the thickness and stoichiometry of the films for the different spin times and speeds. The crystal structure investigation was done using an X-ray diffractometer (XRD), while Fourier transmittance infrared spectroscopy (FTIR) was used to measure the consistency of the molecular structure and structural transformations of the thin films. UV-vis was used to measure the optical transmission of the thin films which resulted in the evaluation of band gap using Swanepoel's envelope method for different thicknesses.

Luminescence and structural properties of Fe3+ doped ZnAl2O4: the influence of charge imbalance

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Introduction
Keeping in mind that the unit cell of spinal ZnAl2O4 is made of tetrahedral and octahedral sites, of which upon doping shows different characteristics. Zn2+ occupies the tetrahedral sites, while Al3+ occupies the octahedral sites. When doped with Fe3+, ZnAl2O4 is characterized by two broad emissions with maxima around 485 and 730 nm [1]. To maintain electrical neutrality, charge balancing should be taking into consideration when doping ZnAl2O4, since charge imbalance can lead to charge defects within the material, which can create non-radiative luminescence centers in the material. We have prepared sets of ZnAl2O4 doped Fe3+ phosphors. To investigate the effect of charge imbalance on the luminescence properties of the phosphors, Fe3+ was used to substitute Zn2+ in one instance and Al3+ in another instance. The site occupancy of the Fe3+ ion was investigated.

Results
The two sets of phosphors are represented by the general formula ZnAl(2-x) Fe_x^(3+)O4 (Fe3+ substituting Al3+) and Zn(1-x)Fe_x^(3+)Al2O4 (Fe3+ substituting Zn2+). The structure, morphology and the elemental compositions of the phosphors were determined using X-ray diffraction, field emission scanning electron spectroscopy and energy dispersive X-ray spectroscopy, respectively. The elemental composition, chemical and electronic states of the phosphors were analyzed using X-ray photoelectron spectroscopy. Both photoluminescence (PL), and cathodoluminescence properties of the phosphors were also studied. The luminescence studies showed that the ZnAl(2-x) Fe_x^(3+)O4 phosphors have superior luminescence than the Zn(1-x)Fe_x^(3+)Al2O4 phosphors, as expected. The band gaps of the phosphors were determined from the diffuse reflectance data.

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Beam intensity improvement of high energy heavy ions beams at iThemba LABS

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There is an increasing interest in high energy heavy ions beams for the study of heavy ion collision physics. The effective acceleration of heavy ions requires high charge states of elements which can in principle be produced in the electron cyclotron resonance (ECR) ion sources at iThemba LABS. However, the intensity of high charge state beams extracted from the source is limited and their transport must be therefore highly efficient. This is especially the case in the low energy region where charge exchange and space charge processes are dominant. In order to improve the transmission from the source through the injector cyclotron to the separated sector cyclotron (SSC), investigations of possible solutions are being investigated. The accomplishments obtained with the recently designed field gradient focusing spiral inflectors and a second 2nd-harmonic buncher will be presented.

Poster Session 1 / 45

Fluka Monte Carlo simulation of gamma photon transport through a distillation column, designed using ChemSep software

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ABSTRACT

ChemSep software was used to simulate and design a distillation column prototype for separating a binary mixture of water and methanol. The behaviour of the distillation column was modelled using MESH equations, which in this work have been solved through ChemSep in order to study the effect of different parameters. The desired methanol recovery was 97%, and in the simulation this was achieved using a total of 9 stages and the feed supplied at tray number 7. As the number of trays is kept constant and the feed tray position is moved down the column, the top composition becomes richer in the more volatile component. The interaction and transport of 60Co gamma photons with the distillation column and its contents, methanol-water solution as well as energy spectrum from 60Co were simulated using Fluka Monte Carlo software package. The results of the interaction and transport of gamma photons are presented as energy deposition on the column and its contents. More energy is deposited on the column walls and plates as compared to the energy deposited in the region between the trays, where there is mostly vapour space.

INTRODUCTION

Monte Carlo simulation of radiation transport and interaction with matter is the most reliable way of predicting the effects of gamma rays [1]. The interaction of gamma photons with matter follows well established laws. Gamma photons can either be absorbed due to the photoelectric effect, scattered by an atom, or converted into an electron–positron during pair production in the field of an atom. The effects of a beam of gamma photon passing through a medium are as a result of many individual interactions because a photon can interact many times before it is absorbed or escapes from the medium [2]. The above processes release kinetic energy to electrons, which escape the atom and also interact with the medium as the secondary particles [3].

The approach to this project was to design a laboratory scale prototype distillation column which will be used to simulate all possible malfunctions that arises in industries during distillation processes. The diameter, height of the distillation column, number of trays and tray separation needed to achieve the degree of separation were determined using ChemSep software, a program which performs multi-component separation process calculations [4]. The prototype distillation column with seven trays was designed using ChemSep, and was modelled in Fluka geometry. A beam of 60Co gamma photons was simulated and incident on the model distillation column. Fluka is a particle physics Monte Carlo software package for simulation of radiation transport [5]. These photons were tracked right from birth and during interaction with the distillation column until their energy falls below minimum threshold or when they escape the region of interest.

Fluka Simulation results

The result is represented as energy deposition on the column in the form of a color map. The simulation results shows that attenuation of gamma photon energy is more pronounced at tray position while there is less attenuation in regions between the trays.

Conclusions and recommendations

The result of the Monte Carlo simulation of gamma photon transport through the distillation column, agrees well with literature. The color map result suggest that if a radiation detector was to be moved along the length of the distillation column, at tray positions it will record less intensity and more intensity at region between trays. Thus energy deposition on the distillation column can be easily converted and represented in the form of a density profile which is distillation column elevation against transmitted intensity. Simulation of all possible malfunctions will be done on the distillation column while running the process and scanned and corresponding interpretations of the density profile will be made.

KEYWORDS

gamma photons, distillation column, simulation, prototype, density profile

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Space Science / 46

Cosmic radiation and space exploration

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We live in an interesting time of space exploration; NASA is planning to return to the moon in 2024 and a permanently crewed lunar outpost also in the pipeline. This is part of a renewed drive to land the first humans on Mars in the 2030's. Private companies, such as SpaceX, also have such plans in place. A major obstacle to long-term crewed missions outside the protective shielding provided by the Earth's magnetic field and atmosphere is, however, the potentially high level of exposure to galactic and solar cosmic rays. Here, we discuss the origin and levels of radiation at and above aviation altitudes, as well as the potential dangers that astronauts experience as a result of varying ionizing radiation levels in interplanetary space. We will discuss our current efforts in forecasting any enhanced levels of radiation produced during solar transient events, including forecasting of the related dosimetric quantities.

Astrophysics / 47

Probing the DA and EoR Using Differential Observations of the SZE-21cm

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Probing the Dark ages (DA) and the Epoch of reionization (EoR), remains one of the challenges facing modern cosmology. Numerous probes have been proposed for exploration of these epochs and efforts are already under-way to detect signatures from them through observations of the 21cm cosmological signal, which corresponds to the 21cm transition of atomic hydrogen. Recently the EDGES collaboration claimed the detection of an absorption feature of the global 21cm background signal centered at 78 MHz. When compared to the standard 21cm models this feature appears at the correct frequency (corresponding to a redshift range of z = (15-20)) but it is larger by a factor of about two in amplitude. This work explores a recently proposed probe for the DA and EoR called the SZE-21cm, we simulate differential observations towards and away galaxy clusters using the standard 21cm models. The SZE-21cm presents advantages as it is a differential measure of the CMB spectrum on and off an area of the sky containing the cosmic structure under study, it is as a result not affected by large-scale foregrounds in observations at low-frequency. We show that observations of SZE-21cm can be carried out with radio interferometers at frequencies between 50 MHz and 250 MHz and used to establish the global properties of the 21cm background spectrum. Noting that detection towards an individual cluster may be challenging we demonstrate how computing the signal for multiple cluster samples may be beneficial and propose the use of the SZE-21cm to test results of current and upcoming experiments such as EDGES.

Astrophysics / 48

Multi-wavelength study of large-scale outflows from the Circinus galaxy

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The Circinus galaxy is a composite starburst/Seyfert galaxy which features 3 kpc scale radio lobe outflows along its minor axis. It is located 4 Mpc away, which makes it a unique target to study the physical nature of these outflows. Our task will be to investigate whether they originate from star formation or jets that resulted from an active galactic core. The MeerKAT array can perform 20 arcsecond resolution radio observations, which is in the observed range of the arcminute lobes of the Circinus galaxy. In this work, a multiwavelength analysis of the radio lobe structures will be conducted using MeerKAT and Fermi-LAT data, which will aid in the understanding of the origin of these structures. The results can then be compared to the star-formation driven Fermi bubbles in the Milky Way, which have also been observed in both the gamma-ray and the radio bands to determine any possible connections to these structures.

Space Science / 49

The effects of drifting warm ions on fast ion-acoustic soliton stopbands

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The effects of the inclusion of finite drift speed for the warm ions on fast ion-acoustic soliton stopbands is theoretically investigated
in a plasma which is composed of cold ions, warm (adiabatic) ions and Boltzmann electrons. The stopbands are intermediate ranges in speed for which solitons cannot propagate, yet soliton propagation is still possible for lower and higher speeds. For warm ions which are drifting along the direction of wave propagation, increasing beam speed results in the widening of the stopbands over the range of cold ion densities. The stopbands are not supported when the warm ion limiting curve is single-valued over the range of cold ion densities for a sufficiently large value of the drift speed. Negative values for the beam speed for warm ions which are drifting anti-parallel to the direction of wave propagation, have the effect of narrowing the stopbands over the range of cold ion densities when the drift speed increases. The considered plasma model may be applicable to conditions in the solar wind where differences between the bulk speeds of the heavier helium ions and protons can arise under some circumstances [1].

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Applied Physics / 51

Analysis of Type 1 diabetes verbal autopsy data by machine learning techniques

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Big data is a term used for data sets with large, diverse and complex structures that are often quite difficult to analyze or visualize using traditional computing methods and approaches. Machine learning (ML) techniques are effective in analyzing these types of data and extracting information from these types of data. Large sets of data are generated by health care systems from record keeping of patients and this data supports a wide range of medical decisions like population health surveillance and disease management for the overall improvement of the quality of health care delivery. In areas where there are no health registration systems like the rural areas of most underdeveloped and developing African countries, a method of verbal autopsy is relied on to give information of a likely cause of death. In this study, type 1 diabetes (T1DM) verbal autopsy data from MRC/Wits Agincourt Unit was used as a test case for applying modern machine learning classification methods to ascertain the cause of death by type 1 diabetes. Machine learning techniques of artificial neural networks (ANNs) and random forests (RF) which are realized with a keras and tensorflow front end were used for the classification task. Machine learning algorithms automatically learn to make accurate predictions based on past observations by learning patterns in the data and for this study, they learn the features present in diabetic patients and are able to identify patients who actually could have died from the disease. This is the first study on type 1 diabetes verbal autopsy data by the two machine learning techniques in South Africa.
The dataset was negatively skewed and performance metrics of precision, recall, confusion matrix and the roc-score were used on these classifiers. Results obtained show that the random forest classifier did the classification task of deaths by diabetes better than the artificial neural network. In particular the roc-score compares favourably with the study that was done by two clinician specialists in the disease whose study was similar, ascertaining the number of deaths by type 1 diabetes from the data.

Physics of Condensed Matter and Materials / 52

CsMn4As3: A new layered tetragonal pnictide compound with an antiferromagnetic ground state

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Search for new high-Tc superconductors (SCs) got a boost in 2008 after the discovery of superconductivity in tetragonal iron-based compounds 1111-type LaFeAsO1-xFx and 122-type AFe2As2 (A = Ba, Sr and Ca). Efforts begun to discover new SCs or their prospective parent compounds and soon a few other SC families were discovered. Two common ingredients of the parent compounds of the iron-based SC families were— stacked square lattices of transition-metal ions and inherent antiferromagnetic (AFM) fluctuations/ordering. We report here the synthesis and properties of a new layered tetragonal transition-metal pnictide compound CsMn4As3. The material is a small band-gap semiconductor and exhibits an AFM ground state. Its crystal structure can best described as a completely collapsed variant of the structure of iron-based pnictide superconductor parent compound BaFe2As2, where the entire middle layer of cations as well as As anions are absent. As a result, the ratio of the tetragonal lattice parameters c/a is only 2.44 in CsMn4As3 compared to 3.28 in BaFe2As2. Owing to the novelty of its transition metal sublattice, this new addition to the family of tetragonal materials related to the iron-based superconductors brings prospects for doping and pressure studies in the search of new superconducting phases as well as other exciting correlated-electron properties.

Poster Session 2 / 53

Super-Hard Materials of the B-C binary system

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A number of potentially ultra-hard materials were examined using ab-initio methods. Compound phases of varying lattice stoichiometry in the B-C-N-O quaternary system, in the forms, C8-xBx (x = 1, 2, 3, 4), C7-xBNx (x = 1, 2, 3) and C6-xBNOx (x = 1, 2) were proposed as possible super-hard materials with useful applications. Cell structures and elastic properties were studied, systematic trends were established. It was determined that C7B and C6BN were mechanically and dynamically stable compounds with potential super-hard characteristics, C6BN being the harder of the two.
The results showed a graphical minimum in the effective values of the isotropic shear modulus, G and Young modulus, E at x = 3 (C5B3) for the C8-xBx materials, this indicates that a much higher boron concentration, i.e. with x > 4, could possibly increase the hardness of these materials; we present a more detailed and extended study (x = 1-7) of the C8-xBx materials.

Astrophysics / 54

Constraining the star formation history with Fermi-LAT observations of the gamma-ray opacity of the universe

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The star formation history (SFH) of the Universe is of fundamental importance to cosmology, not only to galactic formation itself but also for ongoing efforts to determine cosmological parameters and matter content of the Universe. Measurements of the extragalactic background light (EBL) as a function of redshift can constrain models of the SFH, including the initial mass function (IMF) and dust extinction. The gamma-ray spectra of AGN allow us to study the extragalactic background light (EBL) through γ-γ absorption of high-energy photons. In this work, we will use six generic parameter constellations leading to the EBL predictions and compare our results with EBL predictions calculated from observational data. The optical depth for γ-rays owing to electron-positron pair production will be determined for each model and compared to measurements obtained from data.

Theoretical and Computational Physics / 55

Impact-response study of lattice waves and phonons in metallic fcc nanoclusters using the Sutton-Chen potential

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We suggest a novel approach to investigate phonon propagation in an FCC lattice through bond length oscillations in response to a single atom velocity perturbation. The lattice is modelled using the Sutton-Chen embedded atom model (EAM) without any energy loss mechanisms. We begin by showing that the concept of the cut-off distance must be abandoned to meaningfully simulate the transient behavior of nanoclusters. Oscillations are shown to arise and propagate through the lattice as a result of the interatomic potential. The waves, which have fundamental frequency and velocity, are put into the context of Debye theory and are shown to aptly postulate bulk and surface phonons. Calculations of the C11, C12 and C44 directional moduli of elasticity calculated along the <100>, <110> and <111> directions on a thin, nanosized slab-shaped Cu lattice consisting of 2281 Cu atoms are in good agreement with the literature values at the attained simulated temperature. We also show how the cluster temperature is affected by the passage of the wave.

Poster Session 1 / 56

THE INFLUENCE OF PHOSPHATE ROCK STORAGE ON GROSS ALPHA AND GROSS BETA ACTIVITY CONCENTRATION OF NORM IN SOIL SAMPLES FROM RICHARDS BAY, SOUTH AFRICA

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Uranium-238 (238U) and thorium-232 (232Th) are the parent primordial nuclides who along with their progenies are sources of radiation exposure to which humans are exposed directly or indirectly. 238U decay to 206Pb after 14 different alpha or beta decays, while 232Th decay series terminate at 208Pb after 10 successive alpha or beta decays. In this study, gross alpha and beta activity concentration of sixty (60) soil samples collected from 30 sampling sites around a phosphate rock storage facility at Richards Bay were first performed. The samples were further analyzed for 238U and 232Th concentration using neutron activation analysis (NAA). The samples were irradiated by thermal neutrons with a neutron flux of about 7 × 1011 ncm-2.s in NECSA's nuclear research reactor (SAFARI 1). Gross alpha and beta activity measurements were performed using a gas flow proportionality counter to estimate the total activity of each sample without regards to specific nuclides. The maximum and minimum gross alpha activity for the soil samples analyzed were obtained to be 5692 Bq.kg-1 and 34 Bq.kg-1 respectively with a mean of 597 Bq.kg-1. Similarly, 4072 Bq.kg-1 and 24 Bq.kg-1 were obtained to be the maximum and minimum values of gross beta activity concentrations respectively with a mean of 518 Bq.kg-1. A correlation coefficient of 0.658 indicating a strong correlation among 238U and 232Th concentration was established. Furthermore, specific activities of 238U and 232Th in a reference phosphate rock samples were analyzed and obtained to be 118 Bq.kg-1 and 783 Bq.kg-1 respectively. These activity concentrations of these primordial radionuclides (238U and 232Th) in the analyzed samples were found to be below the limits set out by the International Council on Radiation Protection (ICRP).

Poster Session 1 / 57

A Review of Milli and Micro-flow Calibration Standards

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This article reviews several milli- and micro-flow calibration standards available for calibration of low liquid flow instruments, such as medical devices. Their designs and measurement principles are discussed together with supported flow rates and measurement uncertainties. It was learnt that several European national metrology institutes (NMI's) already offer calibration and traceability for low liquid flow calibrations down to 0,1 µL/min with uncertainties of 0,6 % reported in the BIPM Key Comparison Database.

However, in South Africa there's currently no SANAS accredited facility that can offer such low liquid flow calibration services especially for the calibration of low liquid flow medical devices. Hence, the National Metrology Institute of South Africa is currently investigating the feasibility of establishing such a facility to support especially the South African medical industry. The future plans are herein discussed.

Poster Session 2 / 58

Hydrogen sulphide gas sensing behaviour of ZnO nanoparticles doped with cobalt and indium.

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The undoped, 5 % (In or Co) single and (In and Co) double doped ZnO nanoparticles have been successfully synthesised using the ball milling technique. The kenosistec station equipment was used to probe the sensing properties of the doped and undoped ZnO nanoparticles to H2S gas. The current versus time curves plotted for H2S gas, show that the undoped dominates sensitivity followed by the double doped ZnO nanoparticles. Single doped nanoparticles show poor sensitivity to H2S gas. The undoped ZnO nanoparticles acquire optimum sensitivity at a concentration of 20 ppm in the temperature 300 oC. For the double doped ZnO nanoparticles, the optimum sensitivity is observed at 5 -10 ppm concentration at a temperature range of 200-350 oC. The double doped ZnO nanoparticles show fast response, while Co doped ZnO nanparticles show fast recovery time to H2S gas.

Poster Session 1 / 59

Toxicity of Natural Radioactivity in Water Samples from a Gold Mine in Gauteng Province, South Africa

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Naturally Occurring Radionuclide Materials (NORMs) are a common occurrence in the environment, but anthropogenic activities such as mining have resulted in elevated levels of these contaminants in the environment. A radiological toxicity assessment of NORMs in water samples from a gold mining area in the Gauteng Province of South Africa was evaluated. In this study, 29 water samples were collected from around the mine and 5 water samples were collected from the control area for laboratory analyses. A broad energy germanium (BEGe) detector with a relative efficiency of 60 % and a resolution of 2.0 keV at 1332 keV gamma ray emission of Coibalt-60 was used to measure the activity concentrations of these NORMs. The average values for Uranium-238 (238U), Thorium-232 (232Th), and Potassium-40 (40K) in Bq.L-1 were 0.66±0.03, 0.56±0.03 and 7.36±0.58, respectively. These activity concentrations were used to calculate radiological hazard parameters for the area. The average value of the Radium Equivalent Activity (Raeq) in water samples from the mining area was found to be 2.03±0.07 Bq.L-1. This was significantly higher than 1.39±0.08 Bq.L-1, a figure estimated from the control area. The values recorded in all the water samples were, however, lower than the allowable limit of 370 Bq.L-1. From the calculations the average outdoor absorbed dose rate in air due to 238U, 232Th, and 40K in water samples from the mining area was found to be 0.95±0.03 nGy.h-1. From this figure, the Annual Effective Dose Equivalent (AEDE) calculated, recorded an average of 1.17×10-3 mSv.y-1, a figure greater than 8.39×10-4 mSv.y-1 recorded from the control area. These AEDE values were also way below the worldwide average of 0.48 mSv for external terrestrial radiation. Average external hazard (Hex) index for water samples from the mining area was found to be 5.49×10-3 while the average internal hazard (Hin) index was 7.28×10-3. Both these quantities were less than unity, making water samples safe to the population in the area.

Physics Education / 60

Modelling instruction in ECP

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This paper describes the practice used in an Extended Curriculum Program (ECP), on DC circuits. ECP is a program to support the first-year university students, who qualified for the entry but did not perform well in the grade 12 national examination, from under-performing rural community schools in South Africa. In order to improve the performance of these students, the traditional pedagogy replaced with the Modelling Instructions (Hestenes, 1987).
Modelling instruction (MI) focuses on student centered learning and the teacher acts as a facilitator. Students are trained as scientists; they construct, validate and apply scientific models in a specific context. Students learn to predict, design experiments and use models in different situations. Throughout the modelling instruction the teacher has a definite agenda and specific objectives for every class activity: concepts and terminology to be introduced, conclusions to be reached and misconceptions to be addressed. The teacher uses Socratic questions and plays the role of a physics coach rather than a traditional teacher. To the students, the skilled teacher is transparent, appearing primarily as a facilitator of student goals and agendas. This talk presents the pedagogy used in the ECP curriculum and the effects of attitude of students towards the new approach.
The Aspects of Circuit Questionnaire (ACQ) (John & Allie, 2017) is used to measure the effectiveness of the project and compared with the traditional group.

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Physics of Condensed Matter and Materials / 61

Investigating the effect of Co addition on the stability of B2 TiPd system using DFT approach

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The TiPd alloy exhibits thermoelastic martensitic phase transformation above 823 K and has potential for high-temperature shape memory applications. Previous studies showed that this alloy is unstable displaying a negative C′ at room temperature. In order to improve their properties, the effects of partial substitution of Pd with Co are being investigated. The structural, thermodynamic and elastic properties of TiPdCo alloys were simulated using first-principle calculations within the generalized gradient approximation based on density functional theory. The heat of formation increases with an increase in Co concentration, indicating stability at various compositions decrease. The independent elastic constants results revealed that stability is attained at above 31 at. % Co in agreement with the phonon dispersion curves. The calculated moduli confirm that alloying with Co effectively increases hardness and ductility in TiPd systems. These findings can have important implications for future materials design in aerospace industries.

Poster Session 2 / 62

The Study of Microwave Power Effect and Anisotropic Effect in Ba0.34K0.64Fe2As2 (BaK122) Superconducting Single Crystal Using Non-Resonant Microwave Absorption Technique.

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Non resonant microwave absorption technique at liquid helium temperature has been used to study the microwave power effect and anisotropic effect on the hysteresis loops of superconducting BaK122 single crystals measured at 9.4GHz below Tc (32 K). We have found a striking microwave power effect on the hysteresis loops that were measured and a strong anisotropy was found for the two distinct cases where magnetic field applied parallel and perpendicular to the Iron Arsenide plane. We interpret the wide and narrow hysteresis loops as due to the microwave power induced phase locking of several numbers of junctions into coherent groups and then the destruction of the phase locking by the applied DC field leading to the fluxon motion , which gives the loss in individual junctions belonging to these otherwise coherent groups.

Physics of Condensed Matter and Materials / 63

The Ab Initio Study of Ti50Pt50-xHfx (x = 6.25, 18.75, 25) Potential Shape Memory Alloys

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The ab initio density functional theory approach was employed to study the effect of Hf addition to the TiPt binary shape memory alloys (SMAs). SMAs have the ability to retain its original shapes after deformation and have been widely used in the fields of engineering and medicine due to their shape memory effect (SME) and super-plasticity which are displayed in martensitic transformations. Previously, the B2 TiPt system was reported to be unstable with respect to negative C′ and phonon soft modes. In this work, a supercell approach method in VASP was used to substitute Pt with 6.25, 18.75 and 25 at.% Hf in the TiPt. We have found that the calculated heats of formation predicted that 6.25 at.% Hf to be thermodynamically stable structures. The calculated elastic properties confirmed stability of the TiPtHf at different concentration of Hf content with all the Cij being positive. It is thus observed that Hf addition enhances the stability of the B2 TiPt. Moreover, phonon dispersion curves indicated that increasing the Hf content in the system stabilizes the structure with no soft modes observed. These findings suggests that Ti50Pt43.75Hf6.25 has shown potential for alloy development with promising industrial application.

Poster Session 2 / 64

Structural stability of some graphene oxide formations

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The classical molecular dynamics was used to study various forms of graphene oxide possible formations focusing mainly on the structural stability. The structures were modelled at 300 K through the NVT Evans ensemble. Variations of the total energy against the a-axis was explored in which the equilibrium properties were computed. Pair distribution functions as well as structure factors were plotted. In the plots nearest neighbour distances and their neighbouring number of atoms were obtained. To probe the mobility of oxygen in the systems, the mean square displacements as well as the velocity auto-correlations were plotted.

Poster Session 2 / 65

Equilibrium and electronic properties of cubic copper sulphide

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The equilibrium and electronic properties of the cubic copper sulphide are investigated using the full-potential all electrons first principle density functional theory. Convincing equilibrium and electronic properties are obtained using the GGA-PBEsol type exchange-correlation functional. Equilibrium properties suggest the mechanical stability with elastic anisotropy. The electronic band structure and the density of states suggest the material to be semi-metallic with no energy bap.

Poster Session 2 / 66

FIRST-PRINCIPLE STUDIES ON THE STRUCTURAL, ELECTRONIC AND MECHANICAL PROPERTIES OF L10 FePt

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Bimetallic FePt nanoparticles with $L1_0$ structure have recently gained a lot of consideration in practical applications for solid-state devices, storage of ultra-high density magnetic data and biomedicine. This is due to their high magnetic anisotropy, high magnetocrystalline anisotropy, high density, and high coercivity. These materials are also considered as nanocatalysts for growth of carbon nanotubes of different chiralities. In order gain knowledge on the structural, electronic and mechanical properties of FePt, we have carried out first-principle calculations to determine the equilibrium lattice parameters, band structure, density of states, elastic and vibrational properties 0 K. We have employed the plane-wave pseudopotential method framed within the density functional Theory (DFT) as implemented in VASP code. The Perdew–Burke–Ernzerhof (PBE) exchange-correlation functional is used with the Hubbard U-correction in the rotationally invariant form to address the self-interaction energy. The calculated equilibrium lattice parameters were found to be in good agreement with the experimental data to within 1 %, validating the approach employed. The electronic band structure and density of states have shown that FePt is metallic, due to the absence of energy band gap around the level. The bulk (209 GPa) and shear (261 GPa) moduli are relatively large, suggesting high hardness and stiffness. Finally, all elastic constants are positive and phonon dispersion curves shows no negative vibrations, suggesting mechanical stability.

Applied Physics / 67

Quantum Metamaterials: The past, current and future perspective on quantum communication and information science.

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Metamaterials are artificial engineered periodic structures with exceptional optical properties that are not found in conventional materials. As a result of the material unique optical properties, new ways of controlling and manipulating light at the nanoscale is now possible. Thus, leading to many applications most particularly to quantum communication and information processing. Other notable applications where quantum metamaterials have been used include sensing and metrology, energy harvesting, electromagnetic cloak and super-resolution imaging. Quantum metamaterials have been used in addition with other nano-photonics devices to enable on-chip photonic circuitry, quantum reconfigurable devices and to perform quantum state engineering task. Using metamaterial at the quantum scale is still relatively new and research in this direction is rapidly growing. This study briefly reviews the current and future state of quantum metamaterials with applications to quantum communication and information processing.

Poster Session 2 / 69

Electronic and vibrational stability of M9S8 (M= Ir, Rh,) pentlandite-like structures: ab-initio study.

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Metal sulphides are important in many fields of science such as in metallurgy, materials science, geochemistry, physics, geology and chemistry. They serve as a source of the world's precious metal-bearing minerals that are economically and industrially significant. The Bushveld Complex has the largest concentration of platinum group elements (PGEs) which are hosted in the base metal sulphides (BMS). Pentlandite minerals are known to host such precious metals, either as solid solutions or as intergrowths. The existence of the PGEs in pentlandite structure is a promising formation of new pentlandite-like system. Thus there is a need to investigate the formation and stability of Ir9S8 and Rh9S8 in pentlandite-like structures. In this study ab-initio density functional theory was used to investigate phase stabilities of Ir9S8 and Rh9S8 pentlandite-like systems. The calculated elastic constant of the systems were found to satisfy the mechanical stability of cubic systems. Furthermore, the heat of formations calculated were found to be negative, suggesting stability. The density of states of showed high stability in these systems as their Fermi energy falls into the pseudo-gap, this is in agreement with previous work. Moreover, their phonon dispersion curves appeared to have no negative frequencies (soft modes), hence they are vibrational stable. These findings provided new knowledge that establishes the stability of the PGEs existence in pentlandite-like structure that could be applicable in geological search of such phases.

Poster Session 1 / 70

Microstructural characterization of Titanium to copper alloys with their antibacterial rate improvement for biomedical application

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Ti-Cu alloys are promising alloys for biomedical application in dentistry. Previously, metal ions (Ag+ and Zn+) have been widely used as antibacterial agents, however these ions have been found to be toxic to the human body [1]. Copper has been preferred as a good antibacterial agent due to its low toxicity and high cytocompatibility. The current study is aimed at producing biocompatible Ti-Cu alloys with good mechanical properties, corrosion resistance and antibacterial properties.

Methods
Several TiCu alloys were synthesized with the following composition: Cp-Ti, Ti-0.88wt.%Cu, Ti-2.44wt.%Cu, Ti-3.24wt.%Cu and Ti-10wt.%Cu. The alloys were then exposed to staphylococcus epidermidis bacteria. Then they were characterized using the scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS), scanning transmission electron microscopy (STEM), focused ion beam SEM (FIBSEM) and transmission Kikuchi diffraction (TKD) technique.

Rsults of this study will be available during the date of the conference presentation

Theoretical and Computational Physics / 71

Dark matter in the Randall-Sundrum model

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We consider simplified dark matter models (DM) interacting gravitationally with the Standard Model particles in a Randall-Sundrum (RS) frame work. In this frame work the DM particles interact through the exchange of spin-2 Kaluza-Klein (KK) gravitons in the s-channel with the SM particles. The parameter space of RS model with universal couplings to SM particles is known to be strongly constrained from the LHC data. We are thus led to consider models with non-universal couplings. The first model we consider in this study is a top-philic graviton model in which only the right-handed top quarks are taken to interact strongly with the gravitons. In the second lepton-philic model, we assume that only the right-handed charged leptons interact strongly with the gravitons. We extend the study to include not only the scalar, vector and spin-1/2 fermions but also spin-3/2 fermionic dark matter. We find that there is a large parameter space in these benchmark models where it is possible to achieve the observed relic density consistent with the direct and indirect searches.

Space Science / 72

Counter-electrojet occurrence as observed from C/NOFS satellite and ground-based magnetometer data over the African and American sectors

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An analysis of the counter-electrojet occurrence (CEJ) during 2008-2014 is presented for the African and American sectors based on local daytime (0700-1700 LT) observations from the Communications and Navigation Outage Forecasting System (C/NOFS) vertical ion plasma drift (equivalent to vertical E × B at altitude of about 400 km) and ground-based magnetometers. Using quiet time (Kp≤3) data, differences and/or similarities between the two datasets with reference to local time and seasonal dependence are established. For the first time, it is shown that C/NOFS satellite data is consistent with magnetometer observations in identifying CEJ occurrences during all seasons, although it depicts higher CEJ occurrence rate. With respect to local time, C/NOFS satellite also reveals more CEJ events than magnetometer observations despite both datasets showing the similar trend in CEJ identification

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Poster Session 2 / 73

WATER ADSORPTION ON PtAs2 (111) SURFACE: A GENERAL PICTURE FROM DENSITY FUNCTIONAL THEORIES

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Most of the world's supply of platinum and palladium and associated elements comes from mines within four major layered igneous intrusions: the Bushveld Complex in South Africa, the Stillwater Complex in the USA, the Great Dyke in Zimbabwe and the Noril'sk-Talnakh Complexes in Russia. The predominant PGM in the mined area of the Platreef and Merenskyite of the Bush complex in South Africa are (Pd,Pt)(Bi,Te)2, PtTe2, PtAs2, and Pd2As, respectively. The high concentrations of these minerals make it necessary to explore opportunities to maximize the recovery these minerals by flotation. The interaction of these mineral with xanthates, whereby the mineral surface is rendered hydrophobic and gas bubbles can adhere to the surface, has been utilized for many years in practical flotation systems, but this may not be the optimal approach. Industrial mineralogical studies have found platinum group minerals, such as Sperrylite (PtAs2) to be poorly recovered during flotation. Research on the flotation behaviour of Sperrylite mineral is very limited, due to their small size (<10μm), and also the scarcity of individual grains contribute to the complexity of studying fundamental interactions. This study employs ab-initio method to investigate the effect of water molecule on the low index surfaces of PtAs2. The convergent test of slab thickness, vacuum width between slabs and surface relaxation were carried out in order to obtain meaningful results. The results of the adsorption of water molecules on the low index surfaces (100), (110) and (111) are presented and discussed and compared with the available experiment.

Poster Session 1 / 74

Radiological assessment in Weenen agricultural fields

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The radiological hazards were evaluated in the agricultural fields of Weenen, province of KwaZulu-Natal, South Africa. In this study, gamma spectroscopy was used to measure the activity concentrations of these radionuclides in four representative soil samples from the fields and two representative soil samples from the control area. The average activity concentrations in Bq.kg-1 for 238U, 232Th, and 40K from the fields were found to be 99±13, 89±7 and 552.5±21 Bq.kg-1, respectively. On the other hand, the average activity concentrations in Bq.kg-1 for 238U, 232Th, and 40K from the control area were found to be 89.10±10 Bq.kg-1, 79.15±5.60 Bq/kg and 427.33±30.51 Bq/kg, respectively. Radiological hazard indices calculated from these activity concentrations were lower than recommended safe limits. In particular, calculated average values for the radium equivalent (Raeq), external hazard (Hex), absorbed dose (D) and Annual effective dose equivalent (Deff) from the fields were found to be 269 Bq.kg-1, 0.73, 123±6 nGy/h and 0.150 mSv/y. All these values were lower than unity, posing a lower health risk to the farm workers in the area.

Poster Session 2 / 75

Point defects in cubic Boron Nitride(c-BN)

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Point defects in cubic boron nitride are being investigated using the classical molecular dynamics and the rigid Tersoff potentials. In the process, the stability, the structural properties and lattice vacancies are being explored. The formulation uses the NVT Evans ensemble to obtain radial distribution functions and the defect energies for boron and nitrogen vacancies. Boron and nitrogen vacancy defect energies are calculated relative to bulk c-BN total energies. The results suggest that the nitrogen vacancy is more stable compared to the boron vacancy.

Physics of Condensed Matter and Materials / 77

Computational modelling on Stability of Solid Electrolytes in Magnesium ion batteries

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Developing new battery technologies to sustain the ever growing demand of energy storage constitutes one of the greatest scientific and societal challenges of the century. Lithium-ion batteries (LIBs) are at the center of energy revolution, they power millions of portable electronics and electric vehicles. Li ion's success is in part due to the remarkable mobility of Li^{+} in many solids. Fast Li-ion transport enables intercalation electrodes, in which charge is stored by moving the ions in and out of crystal structures. A technology that has the potential to alleviate resource issues with Li-ion systems and further increase the energy density is Mg^{2+} intercalation systems. Replacing Li with safer and earth abundant Mg has the advantage of doubling the total charge per ion, resulting in larger theoretical volumetric capacity compared with typical LIB. Most importantly, in Mg batteries, the anode is constituted by energy dense Mg metal notably surpassing the theoretical volumetric energy density of the current graphitic anode of LIB and even that of lithium metal. In this study we investigate by using first principle calculations within generalized gradient approximation the stability of $MgSc_2S_4$ and $MgSc_2Se_4$ structures. The lattice parameters are in good agreement with experimental studies. The heats of formation indicate that the structures are stable. Calculated elastic properties shows that structures are mechanically stable.

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On the combined analysis of luminescence for thermal assistance and thermal quenching

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If the emission of luminescence is affected by thermal assistance, and if the total probability of emission $1/\tau$ is modulated by a Boltzmann factor $\exp(-E_\alpha/\kappa T)$ where E_α is the activation energy of thermal assistance, the overall probability of optically stimulated luminescence emission can be expressed for *n* electron traps as:

$$1/\tau = [1/\tau_{r\alpha d} + \nu \exp(-\Delta E/\kappa T)] \Pi^{n}_{i} \exp(-E_{\alpha i}/\kappa T)$$

where $T_{r\alpha d}$ is the radiative lifetime, and are as previously defined, υ is the activation energy for thermal assistance for the electron trap and the number of electron traps contributing to the process [1]. We will examine how to quantify thermal effects in cases where the luminescence ensues with very high efficiency such that any little additional component due to thermal assistance and any loss due to non-radiative transitions is masked.

References

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Physics Education / 79

An effective solution to a many-bodied problem in first-year physics

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At Nelson Mandela University (previously NMMU) over the past 4 years, the first-year Physics student numbers in the main stream courses have gone from 140 students to over 500. This has strained the lab capacity, equipment and staff of the department. Late 2017, it was apparent that the current system would not be able to support the influx of students from the new Bachelor of Engineering Technology course offered by the university. In response to this, a document was drawn up based upon the SAIP Benchmark Statement. This document was entitled 'Graduate Skills and Attributes Framework'. It outlined the skills and attributes the department deemed important for Physics students to attain during their studies. The entire practical course was overhauled. Practicals were selected and redesigned to not only improve the efficiency of delivery but to focus on specific skill development. The total number of practicals decreased within the introduction of a week dedicated to the pre-practical preparation and assessment of the students. Post-practical assessment was also included so to ensure each students engagement of the practical.

This paper discusses the developed First Year Practical Course within the Physics Department at Nelson Mandela University. The paper focuses on the benefit of an online system for pre-and-post practical assessment and problems associated with the new system.

Poster Session 1 / 80

Density functional theory study of optical and electronic properties of doped SnO2 with Ge and Sn.

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SnO2 semiconductor cannot proficiently produce UV light because of the large band gap which has ruined its potential optoelectronic application. Doping tin dioxide with different metals components has been considered as a promising method to reduce the band gap of SnO2 so it can improve light effectively in the visible and close infrared region. The electronic and optical properties of undoped and doped structure of SnO2 were investigated Using first principles calculations based on density functional theory (DFT) within the local density approximation (LDA).The different functionals were used to calculate the properties of doped and undoped structure tin dioxide and compare their results. Our results present an important advancement toward controlling the band structure and showing that doped SnO2 can absorb photons on the ultra –violet region and towards near infrared region which is a redshift.

Poster Session 1 / 81

Temperature dependence of local breakdown voltages of crystalline Si Solar cells through voltage dependent ReBEL

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In operation, photovoltaic (PV) modules can experience inhomogeneous shading. This can result in the reverse biasing of individual PV cells. This often results in local degradation of the device material as well as the encapsulant. This affects the performance of the entire module and therefore, the string of modules connected in series within a system. In this study, temperature-and-bias dependent reverse bias electroluminescence imaging (ReBEL) is utilised to generate a temperature dependent breakdown voltage map. This is used to identify specific breakdown types present in crystalline Si PV cells. It is important to understand the effect temperature has on the reverse bias characteristics of PV cells, due to the large variety of temperature conditions PV modules are operated in. Understanding the exact effect temperature has on reverse bias breakdown can improve selection criteria for end-users as it can influence the longevity of the complete PV module. This paper presents a method to determine the map of temperature coefficients of the breakdown voltages of various reverse bias breakdown mechanisms found in crystalline Si PV cells. The results and discussion of the method as applied to a multi-crystalline Si sample as well as that of a mono-crystalline Si sample will be presented.

Applied Physics / 82

Electroluminescence Module Mismatch Analysis (EMMA)

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Electroluminescence (EL) imaging has been utilised in qualitative characterisation of photovoltaics devices since 2005. It has been utilised quantitatively to determine individual cell voltages, as well as individual cell electrical parameters. However, there has been limited work on the development of an analysis technique that combines both the individual cell voltages as well as the local opto-electric properties of each cell. In this study a technique is proposed so as to allow for the study of module mismatch, module degradation and the effect of degradation on module mismatch.
Electroluminescence Module Mismatch Analysis (EMMA) makes use of voltage-dependent EL imaging to determine a set of operational voltage mismatch indices. These indices can then be used to give an estimated power response of a module under different irradiance conditions. This paper presents the development of EMMA as a tool to assess PV modules on a commercial scale utilising the third generation MBJ Mobile Lab.

Poster Session 2 / 83

Sythesis and Characterization of NiO thin films and nano-structures for gas sensing applications

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NiO thin films were deposited at different temperatures (RT,100, 200, 350 and 450 degree Celsius) using a direct current (DC) sputtering system and then nickel oxide nano-structures were synthesized on the deposited NiO film using hydrothermal method. The thin films and nano-structures were subjected to various characterization techniques (X-ray diffraction, Rutherford Back scattering Spectroscope, Raman, UV-Visible, Scanning Electron Microscope, X-ray Photo electrons Spectrometer). The thin films deposited were found to be non-crystalline containing amorphous phases. The deposition temperature was found to have no effect on the film thickness, since all films deposited at different temperatures were found to have the same thickness of 25nm, with uniform distribution of particles on the surface as observed on the Scanning electron microscope (SEM). These NiO thin films were deposited for duration of 1 hour. XPS was used to investigate the presence of Nickel and Oxygen and their oxidation states in as-deposited samples. Gas sensing properties of NiO films and nano-structures were tested on Nitric oxide(NO) gas as analyte, using kenosis Tec gas sensing station.Repeatability and sensitivity of NiO gas sensor was investigated. Short response of 1.5 minutes and recovery times of 1.5 -5.1 minutes were observed on nano-structures compare to thin films.

Poster Session 2 / 84

Temperature dependence of local electroluminescence parameters of crystalline Si Solar cells

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Electroluminescence imaging has been utilised in qualitative characterisation of photovoltaics devices since 2005. Since then, quantitative techniques have been developed. However, the temperature dependence of the emission-voltage response (equation 1) of photovoltaic devices has not been studied in-depth. This work investigates the temperature dependence of the proportionality constant and the luminescence ideality factor. These parameters are dependent on local material properties such as effective carrier lifetime and dark current density. Determining these parameters also allows for increased accuracy at determining local junction voltage at a given global voltage.

Local luminescence ideality factor, has been related to an injection-dependent carrier lifetime. Typically, in multi-crystalline solar cells, recombination-active grain boundaries correspond to non-unity luminescence ideality factor. This also corresponds to non-unity local bulk recombination ideality factors.
This paper discusses the experimental setup and analysis of bias-and-temperature dependent electroluminescence imaging. This paper presents the results of the applied technique on a crystalline Si sample and investigates the importance of local temperature correction in the determination of the luminescence parameters.

Nuclear, Particle and Radiation Physics / 85

Implementing a robust anti-QCD tagger with mass de-correlated jet image data

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We implement a robust anti-QCD tagger with mass de-correlating jet image data produced using the pre-processing method introduced in arXiv: 1903.02032. We take a unsupervised (where the algorithm is trained on a mixture of signal and background data to resemble the proportion of signal and background in ATLAS) and semi-supervised (where data is only trained on background) learning anomaly detection approach using different kinds of autoencoder neural networks for our tagger.
We use jet image data to train our algorithm instead of conventional jet observables. The pre-processing steps perform momentum re-scaling to make all jets have the same mass thus mass de-correlating the jets, Lorentz transformation to make all jets have the same energy and remove the residual rotation by applying the Gram-Schmidt on the plane transverse to the jet axis. This is expected to increase the sensitivity of the autoencoder to non-hypothesised resonance and particles as it will not face the drawback experienced by most machine learning algorithms as they tend to learn the non-linear correlation of the jet-mass with other jet observables.

Applied Physics / 86

Construction and testing of a magneto-optical trap for laser cooling of rubidium atoms

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Cold neutral atoms are currently being used in many areas of quantum information processing, such as single photon sources, entangled photon generation, quantum simulations involving cold atoms in optical lattices, etc. Atoms are cooled using a device incorporating laser cooling together with magnetic trapping called a magneto-optical trap (MOT). We describe in this presentation the basic principles of laser cooling and the design, construction and testing of the MOT for cooling of neutral rubidium atoms.
Our system consists of an octagonal vacuum chamber having a number of view ports, plus vacuum pumps, piping, vacuum gauge and valves. Three stages of pumping are used to reduce the pressure from atmosphere down to ~ 10^(-10) mbar. Rubidium atoms stored in a getter material are released into the vacuum chamber by means of electrical heating. Three pairs of counter propagating laser beams, each pair positioned on opposite sides of the chamber along three orthogonal axes, are used for cooling the atoms in the chamber. Two lasers are used and frequency locked using saturated absorption setups and a PID controllers. One laser is frequency locked to the 5S1/2 (F=2) to 5P3/2 (F=3) cooling transition of rubidium 87. Since the atoms eventually move out of the cooling transition cycle, another laser is locked to the 5S1/2 (F=1) to 5P3/2 (F=2) repumping transition. The cooled atoms are trapped using a pair of anti-Helmholtz magnetic coils positioned on either side of the vacuum chamber. Measurements of the cold atoms have been conducted using CCD cameras. By measuring the fluorescence of the cooled atoms, the number density, size of the atomic cloud, and temperature are inferred. We provide measurements of these.

Poster Session 1 / 87

Density functional theory study of Cyanidin (Cy) dye molecule adsorbed on (100) TiO2 anatase surface for application in DSSCs

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The dye sensitized solar cells have attracted more attention due to their low cost, transparency and flexibility. These types of solar cells use the dye molecule adsorbed on TiO2 semiconductor in nano architectural form with the role of absorbing photo catalytic properties only in the ultraviolet region of solar spectrum. TiO2 absorbs light in the ultraviolet spectrum but can be photosensitized by the adsorption of organic and/or inorganic dye molecules to absorb the light in visible and near infrared regions. In the this study, density functional theory was used to investigate the geometric, electronic and optical properties of cyanidin dye adsorbed on (100) anatase TiO2 surface. Our results show a redshift absorption of cyanidin dye adsorbed on (100) anatase TiO2, with a shift of Valence band towards the conduction band which is the reduction of band gap The adsorption results show a spontaneous electron injection followed by efficient regeneration of the oxidized dye molecules by the electrolyte and strong binding ability to the TiO2 surface.

Poster Session 1 / 88

Development and testing of a single photon detector for Quantum optics experiments

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Quantum communications and computing rely heavily on the use of single photons. Thus there is a need for generating single photons and detecting single photons. In this research we focus on the detection of single photons. We employ avalanche photo detectors (APD) for this purpose. APDs are basically special electrical diodes that are operated in reverse bias beyond the breakdown voltage in the Geiger mode. In the Geiger mode the device is still non-conducting. Upon receiving a single photon an avalanche breakdown occurs resulting in a large current. The device then needs to be quenched before it can detect another photon. In the Geiger mode a high reverse bias voltage needs to be applied and rapidly switched off once a photon is detected. This can be done by means of passive or active quenching methods. In this presentation we provide details of external circuit design of such a single photon detector. Some numerical simulation results are provided together with some experimental results.

Poster Session 1 / 89

Production of metal ion beams with the iThemba LABS ECR ion source

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The demand of scientists for high energy metal ion beams for nuclear experiments has motivated iThemba LABS in collaboration with FLNR, JINR to study their production with using Electron Cyclotron Resonance Ion Sources (ECRIS). The most common method is to heat the metal in an electrical oven inside the source to high temperatures to produce sufficient partial pressure for operation. The special oven design and important features of the oven technique will be presented. Results obtained so far for the following elements; Lithium, Calcium, Magnesium and Bismuth, will be presented.

Poster Session 2 / 90

Title: Facile sensing characteristics of V2O5 nanostructured electrode from experimental and first principle approach.

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To build an efficient and reliable nano-gas sensing device, critical study and analysis of the sensing material in terms of the parameters such as sensitivity and selectivity is a key requirement. In this study, experimental sensing performance of dopantless V2O5 to NH3 gas and its density functional facile properties are presented. The V2O5 sample material was synthesized from NH3VO4 via CVD at 400 $^{\circ}$C under N2 flow for 12 h. Micro- and nano- structural and morphological characterizations revealed the material's structure as polycrystalline V2O5 nanorods. The material was tested for gas sensing application under different levels of NH3 flow. A linear sensitivity % with respect to the levels of NH3 concentration was observed. Furthermore, we also observed optimal sensor response at the operating temperature of 400 $^{\circ}$C. Atomistic density functional calculations of adsorption energies for different numbers of NH3 gas molecules were performed on (001) and (110) surfaces of the V2O5 structure. High adsorption was observed in the case of the perpendicular plane; (001) surface compared with the parallel coordinated (110). The results suggest that, although the orientation has almost equal probability in (001) and (110), the (001) is more selective to NH3 than (110). Absolute value of adsorption energy per molecule with respect to different numbers of molecule does not only simulate the experimental sensitivity profile but also establish the high selective ability of (001) surface to NH3.

Physics of Condensed Matter and Materials / 91

Elastic and Thermal properties of phase change materials (PCM): Sb2Te3 and Ge1Sb4Te7

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Intensive interest on Ge-Sb-Te (GST) based alloys is driven by their outstanding electrical and optical properties which makes them excellent candidates for universal nonvolatile memory applications, also known as the phase change random access memory (PCRAM). The operating principle of the PCM is based on the rapid iterative reversible transition between two structural phases after a threshold voltage. However, their thermal conductivity is critical to device performance since it determines the resistance drift during the cyclic joule heating of the sandwiched active layer. Very few studies have been reported on the elastic and thermal properties of ternary alloys formed from GeTe and Sb2Te3 building blocks. In this work, thin films of Sb2Te3 and Ge1Sb4Te7 deposited by RF magnetron are investigated to establish the dependence of acoustic hardening on Sb2Te3 rich phase change alloy. Using the measured elastic properties and acoustic phonon velocities, the dependence of thermal conductivity on the Sb2Te3 fraction in Ge1Sb4Te7 by surface Brillouin scattering based on the minimum conductivity model is established.

Physics of Condensed Matter and Materials / 92

Effect of Synthesis Approach on the Structural and Optical Properties of Hybrid Perovskite Materials for Photovoltaic Application

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Hybrid perovskite solar cells aroused great interest in the field of photovoltaics lately due to easy fabrication process, tunable band gap within the visible region, high absorption coefficients and carrier mobility (164cm2v-1s-1). In this work, we studied the effect of two processes on the structural, thermal and optical properties of the powder perovskite materials for the application in photovoltaic cells. The perovskite materials for inclusion into solar cells were prepared by one- and two-step solution process to generate polycrystalline structures with diverse grain sizes. The dynamics of the formation of perovskite were monitored by UV-vis spectroscopy, X-ray diffraction and Thermogravimetric analysis. All samples showed an onset of absorption at ~850 nm in good agreement with the band gap value (~1.55 eV) of the perovskite materials. The samples prepared using two-step solution process resulted in smooth XRD patterns, hence showing better crystallinity as exhibited by sharp peaks than those for one step process. The crystallite size of the samples were in the range of 44-81 nm. The one-step solution sample showed the highest temperature (~7500 C) of decomposition when compared to the two-step solution samples which an average decomposed at (~3500 C).

Applied Physics / 93

FIRST PRINCIPLE STUDY OF HEMATITE (α-Fe2O3) SURFACES STRUCTURE DOPED WITH TRANSITION METALS

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The photocatalytic water oxidation activity of hematite (α-Fe2O3) has been greatly enhanced by incorporating hematite nanoparticles on the reduced graphene oxide (rGO) nanosheets. Photoelectrochemical measurement results show that coupling the hematite nanoparticles with the rGO greatly increases the photocurrent and reduces the charge recombination rate. Transient absorption spectroscopy and time-domain terahertz spectroscopy have provided the direct evidence that the photogenerated electrons have transferred as the mobile carriers from α-Fe2O3 to rGO, which enhances the charge separation and suppresses the charge recombination. The conduction band edge of α -Fe2O3 is highly localized, leading to a heavy electron effective mass and, therefore, very low electron conductivity. Density functional theory was employed to study electronic and optical properties of doped hematite with transition metals. The results showed that the incorporation of Ti and Cr reduces the electron effective mass, which improve the electron conductivity of α-Fe2O3.

Applied Physics / 94

MLEM reconstruction of multiple point sources for UCT PET detector

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At UCT, positron imaging techniques are used to investigate systems of flow for science and engineering applications. As an example, positron emission tomography (PET) measurements are performed of the distribution of liquid in 2D flowing foams to investigate bubble coalescence in mineral froth flotation. The impact of the results and the feasibility of more complex measurements, such as extending the results to 3D and multiphase media, are limited by the simplicity of the image reconstruction techniques and uncertainties around the longer range of the positron in the gas phase. The goal of this preliminary study is to develop an advanced image reconstruction technique, namely maximum-likelihood expectation-maximisation (MLEM), for the PET camera configuration at UCT. PET measurements were performed on multiple point surfaces on the surface of a cylinder. The images were reconstructed with both MLEM and a simple back projection algorithm to ascertain the ability of the technique to reconstruct three-dimensional images. This is a promising first step towards the investigation of bubble coalescence in 3D; the next stage of which will be achieved with Géant 4 simulation of the PET camera and a spherical shell radiolabeled with a positron emitting radionuclide.

Poster Session 2 / 95

Heavy ion beam analysis of ion implanted poly-aniline nano-composites

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Ion Beam Analysis is a suite of techniques used to determine elemental composition and depth profiles of thin film structures. The effectiveness of the analysis is expected to improve with the use of heavy ions due to higher cross sections (such as stopping force and X-ray production). In this project a comparison will be done between analysis with heavy ions and with light ions. The analysis is to be performed as part of the project aimed at developing polymer based nuclear radiation sensors. Several films of PANI were deposited on ITO coated PET substrates via spin coating. The films were then implanted to different doses using 100 keV Ti+ ions to form metal-polymer nanocomposites. RBS, PIXE and ERDA analyses were the carried out at iThemba LABS TAMS to confirm implant doses and depth profiles.

Astrophysics / 96

Orbitally-Modulated X-ray and Gamma-ray Emission from Millisecond Pulsar Binaries

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Black widow and redback systems are compact binaries in which the pulsar heats and may even ablate its low-mass companion by its intense wind of relativistic particles and emission. The pulsar wind drives mass loss from the companion, and an intra-binary shock forms as a site of particle acceleration. Radio, optical and X-ray follow-up of unidentified Fermi Large Area Telescope (LAT) sources has expanded the number of these systems from four to nearly 30. We model the X-ray and gamma-ray spectral components from nearby 'spider binaries', including diffusion, convection and radiative energy losses in an axially-symmetric, steady-state approach. The code simultaneously yields energy-dependent light curves and orbital phase-resolved spectra. Using parameter studies and fitting X-ray and gamma-ray spectra and light curves, we constrain certain model parameters and estimate the very-high-energy gamma-ray flux for two promising sources. We find that nearby binaries that are in a 'flaring state' are promising targets for the future Cherenkov Telescope Array (CTA), and may also be detectable by H.E.S.S. for optimistic parameter choices. Constraining the inverse Compton emission via such observations will probe the particle acceleration in the shock as well as the pulsar wind content.

Poster Session 1 / 97

The Diagnostics and Verification System for the Tile Calorimeter Trigger and Data Acquisition framework of the ATLAS Detector

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During the maintenance period of the Front-End electronics of the Tile Calorimeter of the ATLAS detector, one has to quickly assess their state, first by confirming existing problems, and secondly by assessing the validity of the repairs. The Diagnostics and Verification System (DVS) tests are composed of checks that are used to verify the functionality of the Tile front-end (FE) electronics and is used mostly during the maintenance period. DVS implements similar tests to the Mobile Integrity Check (MobiDick) in an embedded system. MobiDick is the first level tests after repairs, and DVS follows at the second level when the module is inserted back into position and connected to the TDAQ system. The current high-precision DVS tests available for TileCal are run from the command-line using two separate programs executed on separate computers. This is not efficient and is mostly understood by Tile Calorimeter Data Acquisition (DAQ) experts. Sometimes after a drawer repair, negative feedback comes one day later from the offline team about specific errors that both DVS and MobiDick are not designed to detect. More DVS tests should be implemented to be able to improve the quality assurance procedure after the repairs. In particular, a stuckbit test should be implemented, which is currently not available in DVS but it is in MobiDick. DVS tests are designed similar to MobiDick tests but are carried out later to assess the Tile FE electronics later on after the maintenance period. However, DVS should continue to be developed to further integrate online and offline data quality validation.

Applied Physics / 98

Real-time Performance Control and Monitoring for the PPr-TDAQ integration of ATLAS Upgrades for HL-LHC

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A major upgrade to the High Luminosity Large Hardon Collider (HL-LHC)will increase the instantaneous luminosity by a factor 5 compared to the LHC.A complete redesign of the electronic system is required for new radiation lev-els, data bandwidth as well as the clock distribution. A large amount of dataacquired from the detector requires high-throughput electronics for accuratedata processing. The upgrade of this technology involves the integration of Pre-Processor (PPr) and the Trigger Data Acquisition (TDAQ) system for high-throughput electronics. The PPr module has already been designed that will beintegrated with other modules such as Adavnced Telecommunication Comput-ing Architecture (ATCA) system and AMC (Advanced Mezzanine Card) carrierfor the full operation of the high-throughput electronics. This paper presentsthe real-time control and performance of the PPr-TDAQ integration using soft-ware and firmware mechanisms implemented on the PPr. The communicationwith the PPr is implemented through the ATCA shell manager to monitor thehealth status of the system. The final design will be capable to operate up to8 complete modules and will be composed of an ATCA carrier with four AMCslots which will host the CPMs.

Poster Session 1 / 99

Influence of the atmospheric turbulence on a single photon source

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Quantum communication is a means of encoding information in the form of single photons and share that information amongst authorised parties regardless of the presence of an adversary [1, 2]. For free-space communication, the communication is not only threatened by the eavesdropper but also by the atmospheric turbulence since it does have an impact on the information passing through it. Therefore, it is important to study the channel before transferring information through it [1, 2].
Optically atmospheric turbulence is observed as a medium with a refractive index nearly equals to unity which randomly changes over space and time and this causes light to be randomly distorted as it passes through the atmosphere [3]. This means that the radiation passing through the atmosphere might be absorbed, emitted as well as refracted [3]. Optical systems which depends on the propagation of light through the atmosphere must control this phenomenon since it is considered as a quantum channel (free-space) which enables the transfer of quantum information [3].
In this work, we are studying the impact the atmospheric turbulence has on a single photon source by observing how the entangled photons survive through the environment. This is done by verifying the Bell's inequality and by reconstructing the density matrix on entangled states after passing through turbulence [4, 5]. Note that here the atmospheric turbulence is simulated in the laboratory using a liquid crystal spatial light modulator (SLM) and the results are analysed using the aforementioned measurement schemes.

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Poster Session 1 / 100

The development of a test station for the ATLAS Tile Calorimeter Low Voltage Power Supplies

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The initial architecture of the Large Hadron Collider (LHC) was so that it can deliver proton-proton collisions at a centre-of-mass energy of 14\,TeV and with instantaneous luminosity of \(1\times10^{34} cm^{-2}s^{-1}\). The Phase II upgrade of the LHC will increase the luminosity by at least 5 times. The present electronics in the detector is not equipped to handle the expected radiation from higher luminosity. Therefore, all on-detector electronics of the Hadronic Tile Calorimeter (TileCal) will be upgraded. The on-detector electronics are powered by the Low Voltage Power Supply (LVPS). South Africa is responsible for the production 50\% of the core of the LVPS. Here we describe the design and development of a burning station for the electronic boards.

Applied Physics / 101

Reliability testing and upgrade of a Low Voltage Power Supply design for the Front-End Electronics of the ATLAS Tile Calorimeter

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We present the design of an upgraded switching power supply for the front-end electronics of the ATLAS hadron TileCal (Tile Calorimeter) at the LHC. The new design features significant improvements in noise, improved fault detection, and improved reliability, while retaining the compact size, water-cooling, output control, and monitoring features. We discuss the steps taken to test the quality of the new Tile Low Voltage Power Supplies, using a new type of testing station which is developed at the University of Witwatersrand, and will build upon the previous generation of testing stations used in the initial production of the TileCal system. This particular testing station will power the next generation of upgraded hardware in the TileCal system of ATLAS at CERN.

Space Science / 102

Energy losses and propagation times of solar energetic particles

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The focused transport of solar energetic particles has received increasingly more interest in the last couple of years due to upcoming missions to the Sun. Stochastic differential equations offer a numerically robust way to model solar energetic particle events, but very few models exist which utilize the full capability of this approach. A step is taken towards this goal by solving the focused transport equation in the spatial dimension along the Parker magnetic field with stochastic differential equations. This model includes energy losses and can be used to study propagation times, topics which are somewhat unexplored within modelling due to limitations of the numerical schemes used. The effects of solar wind advection and energy losses upon observable characteristics of solar energetic particle events are explored and it is shown that the neglect of these processes would predict incorrect event onset times and peak intensities. Short propagation times and little energy losses are found for high energy particles, as expected. It is found that the average propagation time can be described by the diffusion approximation for cosmic rays, while an improved expression is derived for the average energy loss.

Nuclear, Particle and Radiation Physics / 103

Studies on Isolation efficiency scale factors using the Tag and Probe method in the H→ZZ→4l channel for the ATLAS detector

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In this study, isolation efficiency variations between data and simulation are corrected so that the Monte Carlo (MC) describes the data as accurately as possible. The corrections applied are translated into scale factors. Differences between the MC simulation and the data arise not only because of poor description of the selection efficiencies in the simulation, but also due to the fact that the small impurities in the samples have very different efficiencies from the bulk. This affects the efficiency extraction from the mixed sample if their contribution in the data is not the same as in the simulation. Results on the scale factors using the Tag and Probe method will be presented. The Tag and Probe method relies on the stringent selection of one of the lepton pairs (named the tag) to ensure they were correctly reconstructed and belong to the Z decay.

Poster Session 1 / 104

Compatibility of a simplified BSM model with the observed excesses in multiple lepton production at the LHC

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The discovery of the Higgs boson in 2012 reaffirmed by the Large Hadron Collider (LHC) the Standard Model (SM), detailed measurements its couplings shows a strong deviation in the production of multiple leptons at the Electroweak (EW) scale from the Standard Model (SM) Monte Carlo predictions. The elevated production of lepton could potentially provide direct evidence for new physics Beyond the Standard Model (BSM).

Here we investigate the compatibility of a simplified BSM model with the observed multi-lepton anomalies in the LHC public data. The BSM model predicts the existence of a heavy scalar H with a mass of 270 GeV that decays to a SM Higgs boson in association with a scalar singlet S of 150 GeV.

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High mass VBF Categorization for the four lepton H→ ZZ→ 4l final state with the ATLAS detector

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We Categorize VBF-like events using cut-based approach for njets ≥ 2. This study focuses on the VBF signal optimization for the H→ZZ→4l channel and the separation of VBF events from the events produced via the gluon-gluon Fusion (ggF) production mechanism. The study is based on the ATLAS full Run2 Monte Carlo at the total luminosity of 140 fb-1. Major background contribution is from the qq→ZZ→4l as well as the Electro-weak component of the ZZ backgound which is important in the VBF category. VBF selection efficiency and ggF rejection maps are used to find the optimal signal selection in the VBF production category for four lepton channel.

Nuclear, Particle and Radiation Physics / 106

Search for a new heavy boson in bbyy channel with ATLAS detector in pp at √ s = 13 TeV

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We search for a new heavy resonance in H⟶bbyy decay channel.
The range of the heavy boson mass is between [180-1500] GeV. The
analysis uses proton-proton collision data with an integrated luminosity of 140 fb−1 recorded at a centre-of-mass energy of 13 TeV with the ATLAS detector. In this work, we discuss event selections and signal optimisation. In addition, we compare data to state-of-the-art Monte Carlo simulation on the control region.

Physics of Condensed Matter and Materials / 107

Computer simulation study of HF molecule adsorption on TiO2 rutile surfaces

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Hydrofluoric acid is a candidate that can be used for etching metal oxide surface due to its strong corrosive qualities, However, etching phenomenon is not well understood at the atomistic level. Investigation of HF interaction with TiO2 rutile lower surface index is important for enhancing the etching mechanism. Adsorption geometries and energies of HF on TiO2 rutile lower surface index have therefore been investigated using density functional theory employing CASTEP code. It was found that HF chemically adsorbed on TiO2 surfaces to form Ti-F bond and hydroxyl molecule. The surface (110) was found to be more active in HF adsorption with lower adsorption energy and large charge transfer. In addition, all these surfaces found to have higher adsorption ability with the increasing number of HF molecules. Charge analysis indicated that the dissociated of F atom attract electrons and induced the work function due to the higher electronegativity of fluorine atom. This gives evidence that the adsorption of HF molecules on TiO2 surfaces is by chemisorption.

Nuclear, Particle and Radiation Physics / 108

Searches for Dark Matter via mono-higgs with the ATLAS detector.

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A search for the dark matter in association with the Standard Model like Higgs boson was performed using up to 37 fb^(-1) pp collision data collected by the ATLAS detector at the Large Hadron Collider during 2015−2016 are summarised.
In high energy physics, deep learning is used to increase the sensitivity of physics analyses and provides a handle to evaluate the performance and potential for improvement of traditional physics algorithms.
We use Multivariate Analysis methods to suppress the fake missing transverse energy, using the Boosted Decision Tree we are able to enhance the regression performance of typically weak Multivariate Analysis methods for the dark matter search. In the case of both boosted decision trees the use of machine learning techniques is found to improve the background rejection and the signal efficiency. Linear correlations between the resulting classifiers and the substructure variables are also presented.

Poster Session 1 / 109

Fake lepton background estimation in $H \to Sh \to e^{\pm}\mu^{\mp} + $jets with ATLAS detector

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The estimation of fake lepton background is presented for the physics beyond the Standard Model search in the final state with a pair of different flavor opposite-sign leptons, $e\mu$, accompanied by at least two jets. The search uses the LHC full run-2 data recorded at center-of-mass-energy 13~TeV recorded with the ATLAS detector, with the corresponding luminosity of 139 fb^{-1}. The search extends the standard model by introducing the hypothetical scalar, H, and the additional Higgs-like scalar, S. One of the challenges in most physics analysis is to estimate background processes that can enter the signal region and be misidentified as the signal. This paper focuses on the W+jets background which enters the signal region. From the W+jets background process, there is one real lepton from W and one fake which originate from the jet misidentified as a lepton. In the $H \to Sh \to e^{\pm}\mu^{\mp} + $jets analysis, the fake factor method is used for fake estimation.

Nuclear, Particle and Radiation Physics / 110

Top-quark background estimation for physics Beyond Standard Model in the dilepton and jets final state with the ATLAS detector

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This analysis presents the top-quark background estimation for the $H\rightarrow Sh$ channel using the full Run-2 data, corresponding to an integrated luminosity of 139 fb^{-1} of pp collisions at $\sqrt{s}=$13 TeV.$~$The final state for this analysis is formed by two oppositely-charged leptons ($e^{\pm}\mu^{\mp},\mu^{\pm}e^{\mp},e^{\pm}\mu^{\mp}+ \mu^{\pm}e^{\mp}$) and jets. In this analysis the dominant Standard Model background are the top-quark processes ($t\bar{t}$ and Wt). The top control/validation regions are defined in the 1 b-jet and 2 b-jets phase space, respectively. The construction of the top-quark validation region is defined to correct the Monte Carlo mismodeling observed in the leptonic kinematics. Finally, the derived normalization factor in the top-quark control region is applied in the top-quark processes in both the control region and the signal region.

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Automation of next-to-leading order computations in QCD of the WWjj Background for the Dilepton Final State

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A study is performed for the autonomous computation for cross section at the next-to- leading order in QCD for the WWjj background. The WWjj process is described and simulated using MadGraph with aMC@NLO framework, particularly suited for its parallel computation in Standard Model as well as Beyond the Standard Model theories. Interfacing with PYTHIA8 and HERWIG++ in leading order and next- to-leading order allows for parton shower calculations. The study presents different distributions measured in our phase space characterized by the kinematic and energy behaviour of the process.

Poster Session 2 / 113

Discrimination of Signal-Background events with Supervised and Semi-Supervised Machine Learning in the search for bosons decaying to Z + γ final state

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The amount of data produced in the Large Hadron Collider requires modern techniques to improve the processing, classification and regression tasks. In this study, we develop machine learning algorithms that can learn patterns in the data and lead to accurate discrimination of Signal and Background in the search for new bosons decaying into Z + γ final state. The toolkit for multivariate analysis, scikit-learn boosted decision trees and deep neural networks with tensorflow are employed in this study and compared against each other to find the technique that best improves the quality of the signal in the search for new bosons.

Theoretical and Computational Physics / 115

The Role of Topology in Quantum Communication

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Topology is a branch of mathematics that studies the properties that remain invariant under continuous deformations (deformations that do not include ``cutting'' or ``tearing''). Interest in topological ideas in physics originated in the field of condensed matter physics with the exploration and discovery of topological phases of matter. Furthermore, topology was adopted in quantum computation with quantum error correction and topological model of quantum computation. Recently, there has been an interest in applying topology to photonics; and this has resulted in the field of topological photonics. In essence, topological photonics applies the ideas of topology to the field of photonics. In this paper, we explore the role of topology in quantum communication (quantum communication can be viewed as photonics in quantum regime). In particular, we explore the effects of topology in frequency-coded quantum key distribution (QKD); with focus on topological laser and topological one-way fiber. Quantum bit error rates (QBER) for topologically-assisted frequency-coded variants of the BB84 and the B92 QKD protocols are then analyzed. The results obtained provide a justification for the exploration of topology in quantum communication.

Poster Session 1 / 116

Connecting the Muon g-2 with the Search for New Particles at the LHC

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The muon anomalous magnetic moment (muon g-2) represents one of the long-standing unsolved problems in particle physics. The current value of the discrepancy between the experimental and theoretical values is between three and four standard deviations. The large discrepancy could indicate the existence of new physics. A number of studies have shown that a 2-Higgs-Doublet Model (2HDM) along with an extra singlet scalar S can explain several anomalous results observed in multiple lepton production at the Large Hadron Collider (LHC). This model is considered as a possible explanation for the discrepancy in the muon g-2, and it is shown that the existing constraints on the model do not allow for an explanation of the discrepancy to within 2 sigma. For this reason, additional leptonic degrees of freedom are introduced alongside the 2HDM+S. The contributions from this model to the muon g-2 are evaluated and constraints on the model are presented.

Theoretical and Computational Physics / 117

A Deep Learning approach to the search for γγ in association with missing energy at the ATLAS detector

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The Large Hadron Collider (LHC) generates petabytes of data during each data taking period and machine learning (ML) techniques are required to analyse this data. In particular, Boosted Decision Trees (BDTs) have been the de-facto standard ML tool for this task. However, in the recent past, more modern techniques such as Deep Learning have emerged and there has been growing justification for their use in High Energy Physics (HEP). Deep Neural Networks (DNNs) are known for handling high dimensionality well, which often characterises ATLAS data and thus making them a suitable tool for analysing it. We conduct a comparative study between BDTs and DNNs in classifying signal and background events in the $H \rightarrow \gamma\gamma + \chi $ decay channel. We also consider an unsupervised approach called Weakly Supervised Classification. Preliminary results indicate that DNNs perform better than BDTs, however, more rigorous testing is still required.

Poster Session 1 / 118

New Collective Structures in the Z = 76 Stable Odd Neutron Nucleus ^{187}Os.

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The K = 2^+ bands in the even-even Os isotopes lie at lower excitation energy than in any other nuclei in the Nuclear Chart. This makes them very interesting. In the odd isotopes the extra single neutron can couple to these K = 2^+ structures giving information on the axial asymmetry in the shape of the core nucleus. In ^{187}Os there are two long lived isomers at low excitation energies enabling the coupling of different single-particle neutrons to the K = 2^+ core excitation to be investigated. The ^{187}Os nucleus has not been extensively studied using &gamma-ray; spectroscopy for over two decades, therefore the level scheme has not been well established. In the present study we performed a ^{186}W(^{4}He, 3n)^{187}Os reaction at a beam energy of 37.44 MeV to observe new excited states and thereby extend the known level scheme of ^{187}Os. The AFRODITE γ-ray spectrometer at iThemba LABS was used to detect the prompt &gamma-rays; and the &gamma-;γ coincidences. In this presentation the results on the extended level scheme of ^{187}Os and on the new rotational bands established will be discussed. Directional correlation (DCO) ratios and polarization asymmetries (A_p) are used to assign spins and parities of the states. The band structures will be discussed with reference to the Cranked Shell Model (CSM).

Poster Session 2 / 119

First principle studies on lattice thermal conductivity and thermoelectric properties of $LiYSe_2$

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Thermoelectric materials can convert heat into electricity and thermoelectric devices can play an important role in the efficient use of energy. In this study, we investigate structural, dynamical and mechanical stability of $LiYSe_2$ alongside its lattice thermal conductivity and thermoelectric properties for the first time. The ability of a material to be a applied as the active component in the design of a thermoelectric device is based on the magnitude of its figure of merit, ZT, which includes information on the lattice and electronic transport properties. Given the difficulties of directly measuring ZT experimentally, we computed its value within density functional theory using linearized Boltzmann transport equations in a relaxation time approximation.

Theoretical and Computational Physics / 120

Explaining muon $g-2$ in a 2HDM+S model

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The disagreement between experimental and Standard Model prediction of muon anomalous magnetic moment at the level of 3-4σ is well known. In a two Higgs doublet model with a singlet scalar (2HDM+S), we investigate the possible parameter space of all four types of this model to explain this discrepancy. Further we also analyse the sizeable effect of electric dipole moment within this model.

Physics of Condensed Matter and Materials / 121

Cobalt ion implantation induced modification in band gap, thermal parameters and lattice strain on RF – magnetron sputter deposited Zinc Oxide thin films on borosilicate glass

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Modification of transparent conducting oxide (TCO) thin films using transition metal ion beams has received much research focus due to the possibility of developing diluted magnetic semiconductors (DMSs). DMS materials are potential candidates for application in spin based magnetoelectronic and optoelectronic nanodevices [1]. This work reports on the effects of Co+ ion implantation on band gap, thermal parameters lattice strain and grain size on radio-frequency (RF) magnetron sputter deposited zinc oxide (ZnO) thin films on borosilicate glass substrate. Zinc oxide is a direct band gap semiconductor with a large energy gap and a good exciton binding energy, which makes ZnO to be used extensively in many applications, such as in energy nanodevices and optoelectronics [1].
ZnO thin films of thickness 120 nm were implanted with 170 keV Co+ ions at different fluences ranging from 5x1015 to 5x1016 ions/cm2 using the 200 kV ion implanter at iThemba LABS in South Africa. The implanted Co+ ions were seemingly incorporated into the ZnO matrix as substitutional metallic ions. At high ion fluences, the lattice strain was observed to decrease by 10.92%, while grain size increased by 34.82%. Williamson-Hall analysis in estimation of grain size and lattice strain of implanted samples showed good agreement with the crystallite size estimated using the Debye-Scherrer method. The optical band gaps of implanted samples, from UV- visible absorption spectroscopy, showed interesting improvement. For the sample implanted to a fluence of 5 x 1016 ions/cm2, a 7.52% decrease in thermal factor was observed in comparison with the as-grown sample.

[1] Yuksel Koseoglu. Enhanced ferromagnetic properties of Co-doped ZnO DMS nanoparticles. Journal of Superconductivity and Novel Magnetism, 26:485–489, 2013.

Physics Education / 122

A study on High School Learners' Apathy to Physics Subject – Case Study Of High Schools in Kano Municipality, Kano State Nigeria.

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Physics concepts form a strong background in Science, Technology and Engineering education (STE). High school learners' interest in Physics could significantly improve the enrollment and graduation figures in STE and Mathematics (STEM) professions at the tertiary level of education. This study tries to investigate the factors that could significantly enhance learners' interest in Physics especially in the northern part of Nigeria where student enrollments are generally very low. Questionnaires were administered to some selected high schools learners in Kano State Municipality of Nigeria. Factors such as methods of teaching Physics, the quality of teachers, laboratory setups, cultural and subject orientation among other factors have been elucidated and found to have a strong correlation to learners' apathy for Physics.

Theoretical and Computational Physics / 123

Bottomonia Suppression in Heavy-Ion Collisions from AdS/CFT

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We compute for the first time the suppression of bottomonia in a strongly coupled QGP and compare the results to those from a weakly coupled QGP and to data. Using imaginary time techniques we numerically determine the real and imaginary parts of the binding energy of ground state bottomonia in a potential computed from AdS/CFT and another computed from pQCD. We implement the complex binding energies in a suppression model to determine the Υ(1S) nuclear modification factor in $\sqrt{s}_{NN}=2.76$ TeV Pb+Pb collisions. This simplest strong-coupling, p_T-independent potential leads to a significant oversuppression of Υ(1S) compared to data while the results from the pQCD-derived potential are consistent with data. We also investigate the validity of using complex heavy quark potentials from AdS/CFT for all quark separation r by independently computing the meson spectrum using semiclassical, rotating open strings attached to the D7-brane.

Poster Session 2 / 125

Effect of annealing temperature on the structure, morphology and luminescence properties of mixed phases SrAl2O4/Sr3Al2O6/SrCO3:0.05% Gd^{3+} nanopowders prepared by citrate sol-gel method

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Mixed phases of SrAl2O4/Sr3Al2O6/SrCO3:0.05% Gd3+ nanopowders were prepared via citrate sol-gel method. The effect of annealing temperature (AT) at the fixed dopant concentration (0.05Gd3+) on the structure, morphology and photoluminescence properties of the nanopowders were investigated. X-ray diffraction (XRD) showed that the prepared nanopowders consist of the mixture of monoclinic (SrAl2O4), cubic (Sr3Al2O6) and orthorhombic (SrCO3) structures. It is revealed that crystallite sizes is influenced by the AT. The scanning electron microscope (SEM) images shows that the AT has an influence on the particle morphology of the prepared nanopowders. Transition electron microscope (TEM) showed that the crystallites sizes are in the nanoscale. The photoluminescence (PL) showed that when samples were excited with 272 nm, two emission peaks at 431 nm (violet) and 541 (green) were observed and they are attributed to the defects level within the alumina (Al2O3). The international commission on Illumination (CIE) colour showed that the samples were in the Violet region and the emission colour cannot be tuned by AT.

Astrophysics / 126

Investigating thermal and non-thermal emission in novae

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A nova eruption occurs on the surface of a white dwarf following extensive accretion of material from a less evolved companion star. Their study provides an opportunity to understand the emission processes of expelled material and high-energy emitting shocks among others. Modelling radio observations as an expanding gas emitting free-free emission give insights to ejected mass, the velocity of the remnant and kinetic energy of the outburst. The environments surrounding novae in these models are assumed to be of low densities allowing the envelope to expand freely. However, novae surrounded by dense 'embedded' environments similar to recurrent novae, interaction with the ejecta gives rise to synchrotron emission which in some cases is the dominant emission. We present the case of nova V445 Puppis where the radio light curve is multi-peaked and dominated by synchrotron emission. We model the emission as arising from the interaction of nova ejecta with regions of enhanced densities (shells) in the circumstellar material to determine the amount of mass ejected and energy of the explosion. Most radio models assume the material to be spherical. However, imaging shows evidence of polar and equatorial flows in novae. We apply bipolar models to estimate the ejected mass of V339 Del outburst and compare with theoretical predictions.

Theoretical and Computational Physics / 127

Can bath-induced coherences be useful for thermodynamic tasks?

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Several promising innovations in quantum thermodynamics and more generally in quantum technologies rely on the use of quantum coherences. However, it is far from obvious how coherences, most of the time assumed to be present initially, are supposed to be prepared and what would be the associated energetic and/or entropic costs. These are important questions which might challenge the realisation of these operations or at least their overall energetic efficiency (fundamental in thermodynamic tasks). Nevertheless, it is well-known from superradiance [1] that under
specific circumstances coherences can appear naturally in a system interacting with a bath. Focusing on quantum thermodynamics, we ask the following question: can these bath-induced coherences be useful for thermodynamic tasks? As a partial answer, we use the framework introduced in [2] to investigate the thermodynamic impact of bath-induced coherences in the equilibrium process and steady state of degenerate systems. Focusing on spin (or
two-level atom) ensembles, we show two promising effects emerging from bath-induced coherences. The first one is the mitigation of the bath's action, tending to preserve the energy and entropy of the system against the influence of the bath. This mitigation effect can probably find applications in state protection or state preparation. The second effect is the opposite of the first one, namely the amplification of the bath's action, tending to increase the influuence of the bath on the energy of the system. This amplification effect is promising for instance for cooling tasks and energy storage in quantum batteries.

This work is based upon research supported by the South African Research Chair Initiative of the Department of Science and Technology and National Research Foundation.

[1] M. Gross and S. Haroche, Physics Reports, 93, 301-396 (1982).
[2] C. L. Latune, I. Sinayskiy, F. Petruccione, Quantum Sci. Technol. 4, 025005 (2019).

Nuclear, Particle and Radiation Physics / 128

Optimising the top-quark reconstruction for the W$^\prime$ search in the hadronic channel.

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The search for W'->tb decays in the hadronic final states using the full run 2 data, which was collected by the ATLAS detector at the Large Hadron Collider (LHC), is on going. This search relies on the optimal identification of large radius jets that emanates from the top-quark, hence a study to find a method that optimizes the top-quark reconstruction has been done. To conduct this study, five signal samples with different W$^\prime$ masses were studied. This provides an opportunity to explore different methods that yields the highest efficiency of choosing a top-quark jet. The transverse momentum and the invariant mass of the large radius, and small radius jets contained within the large radius jet were studied. The current method that is used to choose the top-quark candidate has the efficiency of 82%, this study attempts to make improve this efficiency.

Applied Physics / 129

Experimental validation of the hot mirror system

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Solar receivers in solar trough installations are crucial components for transferring the incident solar radiation to a working fluid as heat, which can be used for industrial applications or electricity generation. Losses as thermal radiation dominate at high temperature and must be minimised in an efficient system. Conventionally, this is achieved via a selective coating on the absorber pipe, but a different approach used by us is to coat the glass sleeve with a heat mirror substance to quench radiation losses. Such a system can display numerous advantages. In this presentation, I will talk about the theory behind the heat mirror, how it is implemented in a simulation and how experimental results have validated this idea.

Poster Session 2 / 130

Investigation of beta Ti-Mo phase stability employing the first principle approach

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The improvement for load bearing dental and orthopedic implants of Titanium based alloys have become significant in the medical industry, due to the increase of knee and hip replacement amongst younger individuals and the deterioration of body parts by increasing human age. Hence the need for developing low modulus Ti-based alloys with biocompatible properties and low elastic modulus close to the bone. This study aims to investigate the stability of Ti-based alloys for biomedical applications using the first-principles approach. The stability of beta Ti100-xMox (x=0-10) alloys was investigated with respect to their equilibrium lattice parameters, elastic constants and the density of states. The study employed the density functional theory within the generalized gradient approximation. Addition of the alloying element was achieved employing the visual crystal approximation embedded in CASTEP. Interestingly, the Mo addition stabilizes the beta phase with an increasing C' moduli and the density of states suggest that the phase is being stabilized at a higher content of Mo (20 at.%).

Astrophysics / 131

Emission constraints for the white dwarf pulsar via modelling of its phase-resolved polarisation signatures

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Marsh et al. (2016) detected radio and optical pulsations from the binary system AR Scorpii (AR Sco). This system, with an orbital period of 3.55h, is composed of a cool, low-mass star and a white dwarf with a spin period of 1.95min. X-ray pulsations have also been detected from this source (Takata et al. 2018). Optical observations by Buckley et al. (2017) showed that the polarimetric emission from the white dwarf is strongly linearly polarised (up to ~ 40%) with periodically changing intensities. This periodic emission is thought to be powered by the highly magnetised (5*10^8 G) white dwarf that is spinning down. We fitted a standard rotating vector model to these polarisation emission angle data, and found a magnetic inclination angle (α~90 °) and an observer angle (ζ~60 °). Using zeta and the mass function from Marsh et al. (2016) we could constrain the mass of the white dwarf to M_{WD} = 1.00 ± 0.19. We next applied our model to the orbitally phase-resolved polarisation position angle data from Potter and Buckley (2018b) to find α and ζ vs. orbital phase. We will present our first results to indicate the evolution of α and ζ vs. orbital phase, thereby constraining the spatial origin of the emission.

Physics of Condensed Matter and Materials / 132

The influence of ammonium hydroxide solution on ZnAl2O4 nanophosphor prepared by chemical bath deposition method

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ZnAl2O4 powders were prepared by chemical bath deposition (CBD) method by varying ammonium hydroxide solution (AHS). The volume of the AHS was varied from 5 – 100 mL in order to determine the optimum volume that is needed for preparation of ZnAl2O4 powders. The effect of AHS volume on the structure, morphology, and optical properties of ZnAl2O4 powders was investigated. The X-ray diffraction (XRD) patterns showed that the powder samples correspond to the cubic crystalline ZnAl2O4 phase. The intensity of the most intense peaks increased with the increase in volume of AHS up to 50 mL. The scanning electron microscopy (SEM) results revealed that the AHS volume does not influence the surface morphology of the prepared powders. Transmission electron microscopy (TEM) confirmed that the prepared samples are in a nanoscale region and cubic. Elemental energy dispersive (EDS) analysis confirmed the presence of the expected elements. The ultraviolet - visible (UV – vis) spectra showed that by varying the volume of AHS influenced the band gap (Eg). The photoluminescence (PL) results revealed that 50 mL has the highest intensity.

Physics Education / 133

The Educational Power of Being wrong

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This presentation is based on my article published as "The Educational power of Being Wrong."

I pose the following question: 'Why can you not see color by moonlight?'
and follow a process of scientific conjecture and refutation. I ask a similar question on real and virtual images: 'why does a mirror swap left and right but not up and down?'and conclude with reflections on scientific methodology and how this can be distorted by media and special interest groups.

Astrophysics / 134

NIR imaging analysis of cluster candidates in the Vela Supercluster

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The aim in this survey is to map the distribution of galaxies in the potential clusters that lie within the newly discovered Vela Supercluster (VSCL) found by Kraan-Korteweg et al. (2017). This supercluster at a redshift of about 18000 km/s appears as extended and massive as the Shapley Supercluster. The VSCL is partly hidden in the Zone of Avoidance (ZoA) and so the Near Infrared (NIR) is the most suitable waveband to probe it, since it is less affected by the dust in the Milky Way. We use NIR images from the IRSF telescope which are ~ 2 magnitude deeper compared to 2MASX. Along with the spatial distribution, we also estimate the number density distribution and derive the luminosity functions of these prospective clusters, which allow us to ascertain their masses and quantify their contribution to the observed bulk flow.

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ELECTRON MICROSCOPY ANALYSIS OF NANOCRYSTALLINE DIAMOND LAYERS ON ZIRLO

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There is a need for additional energy generation capacity in South Africa, and the government has identified nuclear power as part of the future energy mix. For safety, economics and reliability of nuclear energy generation the issues that affects the cladding material (i.e. ZIRLO) such as waterside corrosion, which limits the life time of the fuel tubes, must be resolved. Zirconium alloy is the main physical barrier between the coolant system and the nuclear fuel(1). Its principal role is to keep the radioactive products produced during the fission process contained in the fuel pin1. One solution is to find a way to protect the ZIRLO with a protective coating against oxidation. When oxidation takes place in the waterside of the zirconium alloy, hydrogen is released to the coolant and the cladding material absorb some of it which leads to formation of zirconium hydrides that are brittle in nature(2).

Since this problem is surface related the ideal coating must improve the reaction kinetics of the fuel tubes with steam. The aim is to suppress hydrogen generation, since this is related to hydrogen gas explosions under accident conditions. Diamond is known for its outstanding properties, such as high thermal conductivity, low chemical reactivity, extreme hardness, wear resistance and it can withstand high temperatures (3, 4). Due to these properties it has been considered as a material of choice for a large variety of applications (5) especially as a coating material. Since it also has low neutron capture, diamond is a material with applications in the nuclear industry.

This paper reports on the characterization of a nano crystalline diamond (NCD) layer grown on a ZIRLO surface by microwave plasma-enhanced linear antenna chemical vapor deposition (MW-LA-PECVD) apparatus. The samples were grown at the MW-LA-PECVD reactor at the Institute of Physics, Czech Republic using gas mixture of Hydrocarbons-Hydrogen.

The NCD coated samples were sectioned using a diamond wire saw and mounted using carbon stub. The samples were then carbon coated and investigated by scanning electron microscopy (SEM) using secondary electron (SE) imaging. Electron Energy-Loss Spectroscopy (EELS) was used to confirm whether the coating is diamond or a carbon like structure. A Helios NanoLab FIB SEM was used to cut transmission electron microscopy (TEM) lamellae from specific areas of interest. The TEM lamellae were investigated in a JEOL 2100 LAB6 TEM operated at 200 kV.

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Theoretical and Computational Physics / 136

Mode-Mixing in Nanoeggs

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We present a discussion on the mode-mixing behaviour of dipolar and quadrupolar modes in gold nanoeggs. Nanoeggs are reduced-symmetry dielectric core-metallic shell nanostructures capable of supporting hybrid plasmonic modes. We investigated theoretically,
the localized surface plasmon resonances(LSPR) of nanoegg plasmons in both a non-confocal nanorice and a non-concentric nanoshell, using the Drude model, the Rayleigh approximation,
the Fröhlich condition, and the Solid-harmonic addition theorem. We show that certain relationships exist between the LSPR of the nanoegg plasmons and between the LSPR of nanoegg plasmons, nanorice plasmons, and nanoshell plasmons. The LSPR of these nanoeggs possess great tunability at the single particle level and can be explored for biosensing applications.

Physics of Condensed Matter and Materials / 137

XRD, Mössbauer and magnetic study of MxCo1-xFe2O4 (M = Zn or Cd) nanoparticles

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In the current work the TMxCo1-xFe2O4 (TM = Zn or Cd) nanosized compounds with average particle size of about 9 nm were synthesized and investigated by Mössbauer and magnetization measurements. The concentrations of Zn2+ or Cd2+ ions and crystallite size have significant effects on the magnetic properties. The 57Fe Mössbauer spectral studies show ordered magnetic spin state for x < 0.5 and paramagnetic phase for 0.6 < x < 1.0 compositions. This can be explained by the weakening of super exchange interactions between the 57Fe nuclei at tetrahedral (A) and octahedral (B) sites due to the increasing contents of nonmagnetic Zn or Cd atoms. The Mössbauer spectra for Zn- and Cd-based compounds are closely related due to the similar electronic configuration of Zn2+ and Cd2+ ions. The magnetization data reveal the superparamagnetic nature of the compounds investigated. An increase in coercive fields from about zero at room temperature to ~3 kOe at 10 K due to spin freezing has been observed. The temperature dependence of magnetization show blocking temperatures higher than 300 K. The variations of the magnetic parameters such as saturation magnetization, coercive fields are discussed on the basis of Zn or Cd contents and crystallite size.

Astrophysics / 139

Shaken, not stirred: Test particles in binary black hole mergers.

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In 2015 gravitational wave event GW150914 was detected by the advanced Laser Interferometer Gravitational-wave Observatory (aLIGO), with a possible weak transient electromagnetic counterpart GW150914-GBM detected by the Fermi Gamma-ray Burst Monitor (GBM) 0.4s after the detection of the gravitational wave signal. In light of these detections we simulate the dynamics of test particles in the gravitational potential well of a binary black hole close to its merging phase with the eventual end goal of simulating the associated electromagnetic
radiation in binary black hole systems, as this could shed light on binary black hole systems as high-energy accelerators and possible electromagnetic counterparts of binary black hole mergers. The potentials are numerically calculated using nite di erence methods, under the assumption of non-rotating black holes with the post-Newtonian Paczynski-Wiita potential approximation.

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Ab-Initio Investigation of the Electronic Properties of Low Miller Index Surfaces in $LiMn_2O_4$ Spinel.

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Lithium manganese oxide ($LiMn_2O_4$) spinel attracted the most attention as a potential cathode material for lithium-ion batteries because of its three-dimensional crystal structure that allows a smooth diffusion of Li^+ in and out of the material. However, its application as a cathode material is limited by irreversible capacity fading due to manganese dissolution, which is caused by the presence of the highly corrosive hydrofluoric acid (HF) continuously produced by degradation of the common LiPF6-based electrolytes. In this study, we employ the spin-polarized density functional theory calculations with on-site Coulomb interactions and long-range dispersion corrections [DFT+U–D3– (BJ)] to investigate the stability of (001), (011) and (111) surfaces. The surface energies show that the Li-terminated (001) facet is the most stable surface, which is in agreement with the reported literature. To mimic charge/discharge processes, delithiated facets were modeled from the most stable surfaces terminations, and their stabilities were evaluated by calculating the surface free energies. As compared to the surface energies of the pure pristine facets, we observed an increase in energy during delithiation process, which indicate the destabilization effect. Our findings on the $LiMn_2O_4$ low Miller index surfaces more essential when improving the electrochemical performance of secondary lithium-ion batteries.

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A radiative transfer model for hydrogen recombination line masers

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Astronomical masers occur when radiation is amplified by the process of stimulated emission over long path lengths, producing line emission that is much brighter than spectral lines produced by spontaneous transitions. Molecular astronomical masers have proven to be a useful tool to probe conditions in a wide variety of astronomical sources. Masers are also produced by atomic hydrogen formed by recombination in sufficiently dense H II regions. These hydrogen recombination line (HRL) masers have been observed in a handful of objects to date and the analysis of the atomic physics involved have been rudimentary. In this work a new model of HRL masers is presented which uses an nl-method model to describe the atomic populations interacting with free-free radiation from the plasma, and an escape probability framework to deal with radiative transfer effects. The importance of including the collisions between angular momentum quantum states and the free-free emission in models of HRL masers are demonstrated. The model is used to describe the general behaviour of radiative transfer of HRLs and to investigate the conditions under which HRL masers form. The model results show good agreement with observations collected over a broad range of frequencies.

Poster Session 2 / 145

Computational investigation of Structural, Electronic, and Mechanical Properties of Spinel $LiMn_2O_4$

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Over the last decade, energy storage became one of the greatest challenges mainly because of natural depleting recourses and enhanced technology. Several investigations have been made in the quest of alternative energy sources, which are renewable, rechargeable and sustainable to current technologies. Lithium-ion batteries appeared as a promising energy source in low-carbon electricity and electric vehicles. However, one of the major difficulties for improving the performance of lithium-ion batteries required to meet the increasing demand for energy storage devices is the development of efficient and stable cathode materials. In particular, lithium manganese oxide spinel has attracted the most attention as potential cathode material because of its three-dimensional crystal structure that allows a reversible Li^+ diffusion. In this study, we employ the Density Functional Theory (DFT) to investigate the stability of the LiMn2O4 spinel bulk through structural, electronic and mechanical properties. The pristine bulk structure was found to be a magnetic semiconductor with a direct band gap of 0.041 eV. The Density of States (DOS) indicated that the structure is metallic, which is in agreement with the reported literature. The phonon dispersion curves show that the spinel bulk structure is stable, since there is no imaginary frequencies. Our findings give insight on the electronic properties and spinel stability of the bulk structure.

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ION-IMPLANTED POLYANILINE THIN FILMS FOR RADIATION SENSING APPLICATIONS

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Polymer based electronics is an emerging technology that is focused on developing electronic devices using semiconducting polymers that can potentially replace silicon based electronics. Polymer based electronics materials are relatively cheaper to synthesize and are mechanically flexible compared to silicon. Metal-polymer nanocomposites, for example, have distinctive electrical, optical and morphological properties that can be useful for device applications. However, fabrication-structure-property relationships of these materials are not yet fully understood, and this warrants further investigative studies. In this work, ppolyaniline thin films were prepared and deposited on an ITO/PET substrate using a spin coater. The prepared films were amorphous in nature, with nanoparticles that were spherical in shape. The size of the nanoparticles was varying from 7.0 to 269 nm with mean particle size of 194.4 nm. The films were then implanted at cryogenic temperature with 50-keV Cu+ ions to different fluences of 0.5x1016, 1.0x1016, 3.0x1016 and 5.0x1016 ions/cm2 to form Cu+-PANI nanocomposite films. Different characterisation techniques were used to investigate a change in structural, optical and electrical properties of the films due to ion implantation. Moreover, the optical band gap and the resistance of the films were found to decrease drastically at low fluence, followed by an infinitesimal decrease at high fluences. The results, in general, indicate that implantation by copper ions to high fluences can be used as an effective tool to tailor properties of the material so that it becomes resistant to change. This stability is suitable for the material to be used for fabrication of the current and future radiation sensors.

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Sol-gel synthesis and characterization of Er3+ doped and Yb3+ co-doped TiO2 nanoparticles

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New enhanced novel phosphors with high efficiency, persistent luminescence lifetime and intensity are needed for the development of various nano-technologically advancing industries. In this respect, this study will discuss the basic information on trivalent rare earth ions photoluminescence emission (down and up conversion emissions) in the UV/Vis/NIR regime and optical band-gap tuning based on rare earth ions doping and co-doping. Erbium-doped ytterbium co-doped titanium dioxide (TiO2) nanoparticles were prepared via sol-gel synthesis method. The sample characterization was mainly focused on the comparison of the undoped and doped TiO2 samples. The phase analysis and particle sizes of TiO2: Er3+ and TiO2: Er3+-Yb3+ nanocrystals were determined using an x-ray diffractometer (XRD) and transmission electron microscopy (TEM). The x-ray diffraction patterns confirmed the formation of an anatase TiO2 phase. UV/Vis spectroscopy was used to measure the reflectance characteristics of the sample, and the band gap was extrapolated from Kubelka-Munk relation. Phonon quantification in TiO2 was achieved using Fourier transform infrared (FT-IR) spectroscopy. The XPS technique was employed to confirm the formation of various defects. A laser beam with 980 nm wavelength was used to irradiate the sample, and the displayed emission lines of TiO2: Er3+ in the visible region of the electromagnetic spectrum confirmed up-conversion luminescence. Enhancement of up-conversion luminescence intensity due to Yb3+ co-doping was observed, indicating an efficient Yb-Er energy transfer process.

Nuclear, Particle and Radiation Physics / 148

Analysis of a deep neural network for missing transverse momentum reconstruction with the ATLAS detector

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The missing transverse momentum (E_T^{miss}) of a pp collision is an important observable as it serves as a proxy for the transverse momentum carried away by undetectable particles. In addition to Standard Model neutrinos, there exist many theorised particles which would not leave any signals in a detector. Therefore, measuring E_T^{miss} with high degrees of accuracy is critical for the understanding many physical processes which take place at the LHC, in the Standard Model and beyond. ATLAS currently utilises several working points to reconstruct the E_T^{miss} of the hard-scatter interaction using only the observed objects. The optimal choice of working point depends strongly on the event topology. The aim of this project is to investigate the use of a deep neural network, trained using Monte-Carlo samples, to develop a more accurate E_T^{miss} reconstruction, which is independent of topology and more resilient to pile-up effects. We demonstrate how the network improves E_T^{miss} accuracy in both simulated and real data, and how this new method might assist in searches for physics beyond the Standard Model.

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First Principle Study of Metal Oxide 110 β-MO_2 (M= Ti, Mn, V) Surfaces Stability and their Interaction with Li_2O_2

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Metal-air batteries are viewed as the next generation energy storage devices due to their high energy density and environmental friendliness. However, they suffer from production of unstable discharge products which leads to capacity fading of the battery. Several catalysts have been used to improve Oxygen Reduction Reaction (ORR) and Oxygen Evolution Reaction (OER) which will yield stable discharge product. In this study, Density functional theory (DFT) is employed to investigate the relative stability of metal oxide catalysts,(110) β-MO_2 surfaces. Electronic and structural stability of clean and Li-O adsorbed surfaces such as elastic constants, phonon dispersions, density of states and band structures are investigated. The phonon dispersion curves show that clean β-TiO_2 surface is the most stable structure since it does not display vibrations in the negative frequencies along the Γ region in Brillouin zone. The electronic band structures calculated indicate the absence of gap at fermi level of all the surfaces that are adsorbed with lithium and oxygen, thus they are all metallic. These findings are important in improving the cycling performance of Li-air battery and give insight on the reactivity of (110) β-MO_2 surfaces with lithium and oxygen.

Poster Session 1 / 150

Experimental setup for optical observation of ultrasound-assisted cell manipulation

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Ultrasonic technology is available, affordable and non-invasive. We use ultrasound to manipulate biological cells and micromaterials. The ultimate purpose of ultrasonic cell manipulation is the separation and eradication of unwanted cells.

This study presents an experimental setup designed for ultrasonic cell manipulation.

A perspex water-filled container is placed on the microscope stage of an Olympus CKX31 inverted microscope (Olympus Corporation, Shinjuku, Tokyo, Japan) with an Olympus CX PL C-Plan 20× objective lens (Olympus Corporation, Shinjuku, Tokyo, Japan). The objective has a numerical aperture of 0.4 and a working distance of 1.2 mm. The illumination is from the top.

The charge couple device of a FASTCAM MC1 high-speed camera (Photron (Europe)) Limited, West Wycombe, Bucks, United Kingdom) is mounted on the microscope eyepiece through an adapter and connected to its processing unit. The camera is controlled by a laptop computer.

A cellulose capillary with a 200 µm internal diameter is fixed across the intersection of the optical and acoustic focus. Biological cells flow through the capillary. These cells are sonicated with an ultrasound transducer, mounted at variable angles.

This setup enables the study of cellular dynamics with an optical resolution below 1 µm and interframe times below 1 millisecond.

Poster Session 2 / 151

Corrosion Resistance of TiZrN Coatings on ZIRLO Exposed to High-Temperature Oxygen

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The focus of this study is to determine the suitability of TiZrN coatings as a means to enhance the oxidation resistance of zirconium-alloy fuel claddings for light water nuclear reactors. The TiZrN coatings were deposited onto flattened ZIRLO tube-sections with a cathodic arc vapour deposition technique. The characterisation was performed using scanning electron microscopy (SEM) and transmission electron microscopy (TEM) techniques in conjunction with energy dispersive X-ray spectroscopy (EDS). The coatings have a thickness of ~3.8 µm and exhibited a single-phase solid solution of Ti0.42Zr0.58N with a NaCl-type crystal structure and columnar nanocrystals. On exposure to air for 0.5 h, the coatings were effective in the protection of ZIRLO against corrosion from 300 to 600 °C. At 700 to 900 °C, the TiZrN coatings oxidise completely and severe oxidation of the ZIRLO beneath was observed. The coatings provided no protection at temperatures above 600 °C and accelerated the oxidation rate of ZIRLO. The oxidation behaviour of the coatings was also investigated at 500 °C in oxygen for 24 h. The results indicate that the oxidation rate of TiZrN coatings is much higher than that of the uncoated ZIRLO and the degree depended on the microstructure of the formed oxide layers. The TiZr – oxide on the coating surface is characterised by a porous microstructure which is associated with a higher oxidation rate exponent. The coatings provided protection for ZIRLO against corrosion for 20 h as oxidation of the underlying ZIRLO was not observed. The coatings acted as a barrier to block penetration of oxygen ions into the ZIRLO beneath. The premature failure of coatings which occurred after 24 h was accompanied by severe oxidation of the underlying ZIRLO.

Applied Physics / 153

Light Dependent Energy Regulation in Phycobilisomes of Cyanobacteria

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Synechocystis PCC6803 (Synechocystis) are species of Cyanobacteria capable of oxygenic photosynthesis. Phycobilisomes (PBs) are large peripheral light-harvesting antenna complexes located on the thylakoid membrane. PBs absorb light and transfer the energy to the reaction centers of Photosystem I and II. An intact PB contains a total of 396 pigment-protein complexes. A single pigment-protein complex is made of a phycocyanobilin pigment attached to a polypeptide chain with a covalent bond. In Synechocystis, the PBs have a hemi-discoidal shape with six phycocyanin (PC) cylindrical rods radiating outwards from an allophycocyanin (APC) core. The energy absorbed by pigment-protein complexes of the PBs is transmitted to special core pigment complexes, ApcE and ApcD, known as terminal emitters. ApcE is a pigmented core-membrane linker that stabilizes the complete structure of the PBs. Recent Single Molecule Spectroscopy (SMS) studies on PBs (Gwizdala et al., 2016; Krüger et al., 2019) have shown the existence of energy regulation related to blinking. Upon illumination, the PBs switch reversibly between 'bright' emissive, unquenched states and 'dark' quenched states. As the intensity of excitation light increases, the frequency of switching between unquenched and quenched states increases. However, the switching to quenched states dominates at higher intensities and the PBs dissipate excess energy as heat in a quenched state. The exact mechanisms underlying the energy regulation are still unknown. Here we present the first single-molecule investigation of PBs from mutant Synechocystis that lack the terminal emitter pigments ApcD or ApcE to reveal the origins of light-dependent energy regulation.

Poster Session 2 / 154

Structural, electronic and optical properties of rare-earth copper chalcogenides $LaCuX_2$ (X = S, Se): A first principles study

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Structural, electronic and optical properties of rare-earth copper chalcogenides $LaCuX_2$ (X = S, Se) were investigated with density fuctional theory (DFT). The calculated structural properties agree resonably well with previous results and experimental data. Elastic constants satisfy the stability conditions for monoclinic structures, wich confirms mechanical stability for the compounds. Modified Becker Johnson (MBJ) potential band structure and density of state calculation reveals that $LaCuX_2$ (X = S, Se) are indirect band gap semiconductors with DFT energy gaps between 1.30 to 1.50 eV. The fundemental gaps were determined at G_0W_0 level of approximation, while optical parameters such as dieclectric functions, refractive indices, energy loss functions and absorption coefficients were examined by solving the Bether Selpater equation. From the results obtained, $LaCuX_2$ are stable compounds and posses energy gaps suitable for photovoltaic applications.

Poster Session 2 / 155

Effect of structural phase transition of GdCrO4 to GdCrO3 on magnetism

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Rare-earth orthochromites (RCrO3) with orthorhombically distorted perovskite (ABO3) structure exhibit a wealth of magnetic phenomena such as temperature-induced magnetization reversal (TMR), spin-reorientation (SR), spin-flipping (SF), and exchange-bias (EB). These occur as a result of magnetic interactions among the cations such as Cr3+−Cr3+, Cr3+−R3+ and R3+−R3+, where R is the rare earth element, such as Gd, Sm, Tm [1]. Rare-earth orthochromites also form a class of magnetoelectric multiferroics which exhibit the coexistence of ferroelectric and magnetic orders [1]. Some of these materials, such as single crystalline GdCrO3, exhibit a giant magnetic entropy change (ΔSm) at a reasonable magnetic field, making it a potential candidate for the application in magnetic refrigeration [2]. TMR and EB have been reported in several RCrO3 compounds due to the competition between the R3+ moment and the canted weak ferromagnetic (FM) component of Cr3+ ions [3]. In the present work, GdCrO4 samples were obtained using sol-gel technique [4]. X-ray diffraction technique was used to identify the phase of the samples. The as synthesized samples were amorphous in nature showing a broad hump. Calcination of the samples at 630 °C led to GdCrO4 phase formation [5]. Further calcination of the samples at 1030 °C for 1 hour led to the decomposition of GdCrO4 into GdCrO3. Upon heat treatment, the Cr5+ oxidation state in the GdCrO4-zircon phase reduces to the relatively stable Cr3+ together with oxygen loss to stabilize the GdCrO3 perovskite-structure [5]. The role of thermal decomposition of GdCrO4 to GdCrO3 on crystal structure and magnetic transitions, studied using XRD and vibrating sample magnetometer (VSM), will be discussed. Magnetization measurements as a function of temperature (M-T) with different probing magnetic fields were carried out to locate the various magnetic transitions in the samples under different measurement protocols such as zero field cooled (ZFC), field cool cooling (FCC) and field cool warming (FCW). Anomalies in the M-T curves observed at T ≈ 10 K and T ≈ 170 K correspond to spin - flip and Néel transitions, respectively. This is in agreement with previously reported values [1]. The hysteresis loops measured across the transition temperatures validate the magnetic transitions as observed in the M-T curves.

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on the applicability of temperature based models for the estimation of global solar radiation on SAURAN weather stations

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Access to clean energy is essential to promote green economic growth, reduces climate change, increase green employment opportunities, support the provision of social services, and generally promote human development. Solar energy is one of important renewable energy source to supply major part of world's energy demand and can reduce the use of the fossil fuels. The knowledge of solar radiation at a particular area is a key issue for different solar energy applications and installation of solar energy technologies. Photovoltaic as a solar energy conversion system is sensitive to sunlight and ambient temperature. However, for the efficient functioning and better performance of renewable energy systems, the information of solar radiation and its components at a particular location in the ground is very essential. The study focused on evaluation and the applicability of the two temperature-based models i.e. Hagreaves & Samani and Annandale. The statistical analysis results showed that the coefficient of determination is 0.9720. The MBE and RMSE are 0.0020 and 0.0115 respectively. The models were used to compute estimated global solar radiation which finally showed a good relationship compared to the observed data. The study was based on the Southern African Universities Radiometric Network (SAURAN) research stations: University of Venda-Vuwani and Stellenbosch University. The global radiation, maximum and minimum temperatures were obtained from the SAURAN data and they were used in different temperature-based models to estimate the global solar radiation. The global solar radiation and the number of days were plotted against each other. The results showed which models were suitable for the two stations selected and the measured and estimated global solar radiation were compared.

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Correlation of Thermal Imaging and Current-Voltage characteristics of PV module strings

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Thermal infra-red (TIR) imaging is a fast and inexpensive technique for detecting defects in Photovoltaic (PV) modules in large-scale solar PV plants. Abnormalities in the current-voltage (I-V) curve of a module string can be indicative of an underperforming module in the string. The physical location of this fault can only be identified by performing electrical measurements on each module in the string. Since it is not practical and feasible to measure I-V curves for individual modules in a large PV plant, correlating the thermal signatures with electrical I-V parameters of module strings makes it possible to identify and understand the effects of the thermal anomalies on the performance of modules in large PV plants. In this study copper-indium-gallium-deselenide (CIGS) and multi-crystalline Silicon (mc-Si) modules in an operational PV system were investigated and TIR images correlated with electrical performance. Thermal anomalies resulting from module defects were identified and their effect on performance determined. Results show that a single defect such as a crack in one of the modules in a string can result in a power loss greater than 8%. In addition to power loss, defects that result in areas of increased temperature or "hotspots" also pose a fire hazard on power plants. Furthermore, this work has a direct impact on the improvement of the operation and performance in PV plants.

Astrophysics / 158

Deep r-band imaging of CLoGS galaxy groups

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Galaxy groups offer an excellent opportunity to study the impact of galaxies on their intergalactic medium (IGM), and vice versa, as the galaxy's heating process effects are more visible due to the groups' lower density and mass compared to clusters of galaxies. This project is part of an optical observational campaign to observe the Complete Local-Volume Groups Sample (CLoGS), which is a statistically-complete sample of 53 groups within 80 Mpc, with radio observations (GMRT & VLA), X-ray bands, and sub-mm (IRAM-30m) data already available for the entire sample.

For this project, we are interested in the surface brightness profiles of the central, dominant elliptical galaxies in the groups, to obtain stellar mass profiles and structural parameters e.g. size of the cores of the galaxies. Here, we present Multi-Gaussian Expansion (MGE) fits to the r-band (or equivalent) images of 35 central group galaxies, from archival Hubble Space Telescope (HST) imaging and MegaCam / Canada-France-Hawaii Telescope (CFHT) r-band images. For 12 groups, we also present new CFHT MegaCam observations obtained in 2018/2019.

Poster Session 1 / 159

Optimizing the organic Solar cell efficiency with the addition of dyes and nanoparticles.

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Organic solar cells based on ZnO nanorods have been fabricated using inverted architecture and reported an efficiency of 4.6 %. Adding Cu nanoparticles and SQ dyes to both electron and hole transport layers further improved the conductivity of the solar cell. The structure of the solar cell used employed ITO substrate with PCBM, P3HT and PEDOT:PSS as polymers. The results shows that the device can be improved to a complete polymer solar cell which adds to low cost and light weight for applications in smart windows. The final results shows improved efficiency for the overall solar cell.

Poster Session 1 / 160

Effects of current mismatch due to uneven soiling on performance of mc-Si module strings

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Soiling is the building up of contaminants on the sun facing surface of photovoltaic (PV) modules. These contaminants include dirt, dust, snow, bird droppings and other forms of particulate matter. Uneven soiling causes non-uniform illumination on solar cells which results in unequal current generation in substrings of multi-crystalline Silicon (mc-Si) PV modules. The current mismatch results in the soiled cells operating at abnormally high temperature (hotspot) and causes a negative impact on the power generated by the module and string. Underperformance of PV modules can be revealed when the current-voltage (I-V) parameters deviate from the expected. This work investigates the impact of partial shading due to non-uniform soiling (dust and bird droppings) on the performance of mc-Si modules and strings. The results obtained using a simulating program, PVSim, to model the I-V curves of mismatched substrings and compare with controlled soiling experiments carried out at Outdoor Research Facility (ORF) at Nelson Mandela University and also for strings of mc-Si modules in an operational PV plant for which thermal anomalies were observed. This paper discusses the comparison between the simulation and experimental observations with the effect of defects, causing thermal anomalies, on performance being quantified.

Keywords: Uneven soiling, current mismatch, simulation, performance

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Phenomenology of axion-photon coupling in the jets of AGNs

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An outstanding result of modern cosmology is that only a small fraction of the total matter content of the universe is made of baryonic matter, while the vast majority is constituted by dark matter (DM). However, the nature of such component is still unknown and might be a matter of long standing controversies. In principle, the nature of DM can be understood through looking for light scalar candidates of DM such as axion and axion-like particles. The axion is a pseudo-Nambu-Goldstone boson that appears after the spontaneous breaking of the Peccei-Quinn symmetry and it was introduced to solve the CP-violation problem of the strong interactions. On the other hand, there are other axion-like particles (ALPs) predicted by many extensions of the standard model of particle physics (SM) and they postulated to share the same phenomenology of the axion. The theory, together with observational and experimental bounds, predicts that such axions or more generally ALPs are very light and weakly interacting with the SM particles. Therefore, we strongly believe that ALPs are highly viable candidate for cold DM in the universe. If they really exist in nature, they are expected to couple with photons in the present of an external magnetic field through the Primakoff effect. We will examine the detectability of signals produced by ALP-photon coupling in the highly magnetized environment of the relativistic jets produced by active galactic nuclei (AGNs).

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Structural, Optical and Electrical Properties of Methylammonium Lead Tri-iodide on Zinc Oxide Nanorods

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Organic/inorganic hybrid perovskite materials, have attracted much interest for their promising application in solar cells as the light-absorber to the broad spectral absorption, strong light-harvesting and long exciton diffusion length. The perovskite solar cells can reduce the production costs and achieve high power conversion efficiency significantly compared to standard silicon cells and other thin film cells [1, 2]. On the other hand, ZnO based materials have recently been investigated in the PSCs as electron transport layer for low-temperature, low-cost and flexible devices. In this work, we deposited $MAPbI_3$ onto ZnO nanorods.X-ray diffraction patterns confirmed the tetragonal methylammonium lead tri-iodide crystal structure with p4mm space group, with lattice parameters $a \sim 8.330$ Å and $c \sim 10.461$ Å. In addition, the average crystallite size, residual strain and dislocation density of the perovskites we re found to be 25.77 nm, 2.5×10^{-4} and 1.506×10^{11} cm^{-2} respectively. UV-vis absorption spectrum showed the broad with onset of absorption at ~ 780 nm, giving an optical bandgap of 1.59 eV. Surface morphology of pristine ZnO revealed highly oriented nanorods rods that were nearly aligned vertically to the surface with an average diameter of ~300 nm and diameter of ~1.2 µm. High compact grains of grains were observed on perovskite grown on ZnO nanorods with an average grain size of~60 nm. From the semi logarithmic I-V characteristics of ITO/ZnO/MAPbI3/Au Schottky diode. Based on the standard thermionic emission theory the values of Schottky barrier height 0.543 eV, ideality factor 1.982, series resistance 211.204 Ω and the reverse saturation current 5.63×10^{6} A were determined.

Keyword: perovskites, solar cell, ZnO nanorods.

Poster Session 1 / 163

Conductivity studies of Cu nanoparticles and dyes incorporated in both

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Electron and hole transport layers of polymer solar cells have been modified by adding Cu nanoparticles and natural dyes. Hall measurements were used to study the conductivity of different layers on ITO. The results shows improvement conductivity of the hole transport layer, giving a value closer to that of other well known polymers for applications in solar cell.

Astrophysics / 164

Neutrino detections in Tidal disruption events.

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The recent detection of astrophysical very-high-energy neutrinos by IceCube has spurred an intensive search for their sources. As a possible sources of VHE neutrinos, tidal disruption events (TDEs) have been suggested. Here we investigate a jetted TDE- Swift J1644+57 which is the best measured TDE in multiple wavebands- as a candidate astrophysical neutrino source. TDEs occur when a star approaches a massive black hole located at the centre of a galaxy. If the tidal radius is larger than the Swarzschild radius of the SMBH this leads to tidal forces violently disrupting the star. Matter accretes on the SMBH and produces luminous and long-lasting flares. We investigate the neutrino production in the TDE emission region using a hadronic code developed by Boettcher et al (2013). This is done through a parameter study which leads to a production of fits for the spectral energy distribution (SED) of the source and evaluated the expected neutrino detection rate by IceCube. We present a parameter study of how the expected neutrino detection rate depends on various source parameters.

Poster Session 2 / 165

Migration behavior of palladium implanted into glassy carbon

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Migration behavior of palladium (Pd) in glassy carbon was investigated using Rutherford backscattering spectrometry (RBS), scanning electron microscopy (SEM) and Raman spectroscopy. Pd ions of 200 keV were implanted into glassy carbon samples to a fluence of 1×10^16 cm-2 at room temperature. Some of the implanted samples were annealed in temperature ranging from 100 to 1000 oC in steps of 100 oC for 5 hours. Implantation of Pd amorphized Gc.
Diffusion of Pd began after annealing at 400 oC and become more pronounced with increasing temperature. At 600 oC it was accompanied by 10% loss of Pd while at above 600 oC it was accompanied by loss and peak shift towards the surface. From the peaks broadening the diffusion were estimated in the temperature range from 600 to 1000 oC.

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Milk cooling energy optimization on a dairy farm through an energy audit approach

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High energy cost in a dairy farm is of concern and in order to make the business viable serious energy efficient measures need to be taken into account. Mostly, in dairy farms, energy consumption is high during the cooling process of milk before it can be collected for processing. This study was conducted on an existing dairy farm and it presents the optimization of the cooling process of milk on a dairy farm through an energy audit approach. A data acquisition system comprising of a power and energy meter, temperature sensors and flow meter were designed and built to monitor the energy consumption of the milk cooling process, the temperature of the milk and the flow of hot water in the dairy farm. The paper emphasizes the utilization of the waste heat to preheat water that is used for sanitation purposes within the plant. Findings from the study revealed that harnessing low-grade waste heat from the milk before cooling can lead to energy reduction in hot water heating as well as improves the load factor of the bulk milk cooler significantly. An efficient and economical design is considered for retrofit purposes or for new plant designs.

Poster Session 2 / 167

Effect of swift heavy ion irradiation on the migration behavior of strontium implanted into polycrystalline SiC

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The influence of swift heavy ion (SHI) irradiation on the microstructure and the strontium (Sr) migration behavior of Sr implanted into polycrystalline SiC were investigated using Rutherford backscattering spectrometry (RBS), Raman spectroscopy and scanning electron microscopy (SEM). The as-implanted and SHIs irradiated samples were vacuum annealed from 1100 to 1500 oC in steps of 100 oC for 5 hours. Implantation of strontium (Sr) amorphized the SiC, while SHIs irradiation of the as-implanted SiC resulted in limited recrystallization of the initially amorphized SiC. Annealing at 1100 oC already caused recrystallization in both the irradiated and un-irradiated but implanted with Sr samples. At 1500 oC, a carbon layer appeared on the surface of the irradiated and un-irradiated but implanted with Sr samples. This was due to the decomposition of the SiC and subsequent sublimation of silicon leaving a free carbon layer on the surface. SHIs irradiation alone induced shift of the implanted Sr toward the surface. This it may be due to the surface sputtering that caused by SHIs. Annealing the samples at 1400 oC caused a release of all implanted strontium in the SHIs irradiated samples, while 55% of implanted strontium was released in the un-irradiated but implanted with Sr samples. The enhanced Sr releasing in SHIs irradiated samples was explained in terms of the high number of pores in the irradiated samples compared fewer pores in the un-irradiated but implanted with Sr samples. The results show that more Sr was released in the irradiated SiC samples.

Applied Physics / 168

A Deployable Modular Mini-Grid for Electrification in Rural Areas

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With the challenge of supplying electricity to rural regions in South Africa, where the logistical cost of installing a utility line is not economically viable, photovoltaics (PV) for power generation offers a solution to rural electrification. However, pervious pilot projects executed by government and private institutes utilized only DC systems for electrification in typical “solar home systems”. These systems only allowed for battery charging, and in some cases transporting of batteries between households and a charging station. In addition, the use of DC powered appliances is expensive, and does not truly allow for uninterrupted electrification. The deployment of the designed modular hub units will effectively provide AC power to the households and improve livelihoods of the residents.

This paper discusses the design and implementation of an experimental modular mini-grid for AC electrification in remote rural areas. The mini-grid system comprises of AC and DC coupled photovoltaic systems sized for optimal power generation. The heart of the mini-grid is the deployable hub unit that comprise of a DC PV system coupled to the inverter system. These units can provide up to 4 households at a local site. A network is created by coupling more of the hub units together, which in turn, communicate with each other and manage the energy flow to the connected households. The linking of this network to a larger AC coupled PV system aids to increased generation capacity and meet higher instantaneous load draws. The DC and AC systems work together to meet the required loads and effectively charge the battery banks.

This paper discusses the mini-grid configuration and uses the pilot installation at the Nelson Mandela University study energy flow and consumption. This is achieved by using programmable loads that simulate the consumption profiles of 4 rural households that make up a mini-grid unit. The generation profile information obtained is then used for design optimization and identify acceptable power use assignment for end users.

Applied Physics / 169

Reporting on the Southern African Reference Energy Yield Network System (SAREYNS)

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Photovoltaics (PV) has been recognized as one of the major renewable energy sources for utility-scale power generation in South Africa that can potentially meet the shortfall in generation, which ESKOM currently cannot provide. However, to assure the maximum energy yield for a given PV system within a deployed climatic region, long-term reliable performance data of the various technologies need to be obtained. This paper discusses the comparison of performance data from various PV technologies operating within the Southern Africa Reference Energy Yield Network System (SAREYNS) and highlights their importance in decision making for PV system deployment. The analysis performed on the various datasets helps to determine the most suitable PV technology in their respective region in terms of actual energy yield and specific yield. Comparing these energy yield datasets within the network database, a yield forecasting platform for both emerging and current operational PV plants is available.

In addition to forecasting, the identification and tracking of progressive module degradation can be determined. Comparing these datasets, the PV technologies showed specific preferences for the various regions, and under identical solar isolation, the effect of spectral content on the technology performance was also observed.

Space Science / 170

Effects of scattering parameters on charge-sign-dependent cosmic ray modulation.

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A comprehensive three-dimensional numerical drift model is used to compute the modulation of cosmic ray protons and anti-protons in the heliosphere. This is done using the latest development in diffusion coefficients and cosmic ray interstellar spectra. Emphasis is placed on the effects of the spatial and rigidity dependence of the scattering parameter ($\omega\tau$), with ω the gyro-frequency and τ a time scale defined by diffusive scattering, on the drift coefficient in the modulation of the mentioned species. A comparison of the numerical modelling of the ratio of anti-protons to protons obtained from different scenarios of $\omega\tau$ is made over a solar cycle. This charge-sign-dependent modulation study should assist in establishing the amount of drifts present at the Earth from solar minimum to maximum solar activity in both magnetic cycles.

Astrophysics / 171

Unifying Dark Matter and Dark Energy in Chaplygin Gas Cosmology

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One of the most active areas of research in cosmology today involves trying to understand the nature of dark matter and dark energy. In this work we will look at the cosmological background expansion of a universe model filled with a Radiation-Baryon-Chaplygin Gas fluid system. We will show that such a model can solve the dark matter and dark energy problems, at least at the level of the background expansion.

Poster Session 2 / 172

Electrical properties of highly oxygenated silicon diodes.

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Defects in silicon are intentionally and unintentionally introduced into the surface and bulk of silicon diodes. Defect engineering is the manipulation of the type, concentration, spatial distribution and mobility of defects within the material. This is done either by metal doping, impurity doping and by irradiation before the fabrication of the detector. These effects create a cascade of interactions generating interstitial and vacancy defects. The defects recombine in a short time and form chemically stable complexes and clusters of defects. These defects diffuse through the crystal and react with impurities such as oxygen.
Some of these defects under irradiation have a negative impact on the electrical properties of silicon such as shorter minority carrier lifetime, increased leakage current which is due to introduction of generation centres, and the introduction of additional space charge density which will cause variations in full depletion voltage of the silicon device.
These changes are due to deep level acceptor-like radiation induced defects such as di-vacancy bonded to oxygen. V2O is also responsible for the formation of negative space charge under bias.
Improved radiation-hardness can be accomplished by the suppression of the formation of V2O centres and in highly oxygenated silicon devices. For radiation-hardness in silicon devices oxygen concentration is around 1018 cm-3 with high resistivity this is to ensure wide depletion zones thus increasing detection efficiency.

Key words: defect formation, Si electrical properties, radiation hardness.

Poster Session 2 / 173

Alloy simulation of iron aluminides intermetallics

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The Fe-rich part of the Fe-Al phase diagram has offered an overview regarding its capability as a replacement of steel in the application of intermetallic compounds. They are of excellent application in the energy sector, boilers, pipes and automotive parts. These compounds possess good mechanical properties, low density as well as accessibility of raw material. Thermodynamic stability phase diagrams were calculated and elaborated in order to improve the understanding of the corrosion mechanism. We employed VASP code to determine the thermodynamic and electronic properties from their equilibrium lattice constants on each system. In terms of the system stability, there exists correlation between the calculated shear modulus (C′) and Gibbs energy as well as the XRD pattern which corresponds to the FeAl bcc ordered compound. It was found that the addition of Pd, Pt and Ag enhances the stability at various (FeXAlXM)X compositions. The results obtained indicated that Pt substitution stabilised the system more, followed by Pd wherelse Ag showed to be the least in terms of stability.

Poster Session 1 / 174

Preparation of Cu2ZnSnS4/N-MWCNTs as potential Pt free counter electrodes in dye sensitized solar cells

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Cu2ZnSnS4(CZTS) is a quarternary chalcogenide composed of earth abundant and low toxicity elements. It has been reported to exhibit excellent catalytic activity, thus can be employed in dye sensitized solar cell (DSSC) counter electrodes for reduction of electrolytes to replace platinum. However, Cu2ZnSnS4 has low surface area and poor electron conductivity, which can be counter-acted by reinforcing it with nitrogen doped multi-walled carbon nanotubes(N-MWCNTs). N-MWCNTs show high electron transport properties due to incorporation of nitrogen atoms which creates structural defects in the carbon network.The interaction between CZTS and N-MWCNTs was evaluated by Raman spectroscopy and transmission electron microscopy characterization techniques. A hybrid system of the two compounds shows promising reduction capabilities of the DSSC electrolyte as evaluated by cyclic voltammetry.

Poster Session 2 / 175

The effect of iron-particles on the electrical properties of n-GaSb semiconductor material

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Semiconductor material are characterized with the Schottky barrier diodes (SBDs) as a basic structure. The study was conducted in order to check the effect of iron particles on the electrical properties of Gallium antimonide (GaSb) semiconductor material. Gallium Antimonide (GaSb) was implanted with iron particles at various ion fluences ranging from 1.2 × 10^15 to 1.2 × 10^17 cm^-2 while keeping the ion energy at 90 keV. Aluminium (Al) Schottky barrier diodes (SBDs) were fabricated on Te-doped n-type Gallium Antimonide implanted with Fe+ at various fluences. Structural and electrical properties have been investigated using the Raman spectroscopy and I-V characterization. I-V measurements were performed for all the samples. Raman spectroscopy shows a slight amorphization at fluences higher than 1.2 x 10^15 cm^-2. The ideality factor (n) increased from 1.3 for the undoped to 2.0 for 1.2 x 10^17 cm^-2. The barrier height was found to decrease from 0.735 eV for 1.2 x 10^17 cm^-2 to 0.653 eV for 1.2 x 10^17 cm^-2. Generally, the barrier height decreased with the increasing doping fluences while the ideality factor increased with the increasing doping fluences.

Poster Session 1 / 176

AN OVERVIEW OF THE iTHEMBA LABS CYCLOTRONS AND ION SOURCES

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The Separated Sector Cyclotron, which is the heart of the iThemba LABS facility, has now been in operation for more than three decades. Over the years numerous improvements have been made to the existing facility. These include the installation of two novel flat-topping systems, simultaneous target irradiations with the installation of a beam splitter system as well as new and additional diagnostic equipment which has been installed. All these improvements will be presented. A general discussion on the various ion source improvements will also be presented.

Theoretical and Computational Physics / 177

Non-Abelian Corrections for Radiation in QCD

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We compute the emission spectrum of soft and collinear gluon bremsstrahlung radiation associated with the hard scattering of a quark by a gluon in QCD for one, two, and three gluons. In QED, multiple photon emissions are independent, which is to say they are emitted according to a Poisson distribution. In QCD, the non-Abelian nature of the theory leads to interactions between the emitted gluons. Hence the emissions are not independent, and there are therefore corrections to the Poisson distribution of these radiated particles. We present the first explicit calculation of these corrections, which exploits maximal helicity violation techniques, and its relevance for heavy ion collision phenomenology.

Physics Education / 178

Perceptions of preservice teachers on the impact of the use of media in the teaching and learning of Physical Science in schools

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Teaching and learning media is one form of teaching strategies also known as instructional media. Instructional media influence and affect the way and how physical science is taught in schools. This survey study was conducted with pre-service teachers to investigate their perception on the impact of instructional media in the teaching and learning of physical science in schools. The participants were tasked to use teaching and media strategy during their practice teaching period in schools and make observation on that. They were then asked to deliberate, on their return back to campus, what effect it had in their teaching of the subject or subject content or topics. Initially they had mixed feeling about the concept but finally they saw and agreed on its benefits after learning of how a constructivist approach enhance learners' understanding of the concept. Though some say it consumed too much time of the lesson as learners tend to get excited and give their own views and argue about them, it is good approach to build on to what the learners already know and diffuse their misconceptions and myths about the topic of the day. they also agreed that it applies in almost all the physical science topics. The approach just needed a teacher-controlled environment to direct and limit the learners' response without degrading them or depriving or suppressing them of their opinions. Consequently, they agreed that learners learn best when they are actively involved with the teacher facilitating the learning and explaining the science concepts' meaning and laws to arrive to the point or support their responses and allay their misconceptions. That means the teaching will be learner-centered and it helps the learner enjoy the lesson, understand concepts better and be interested in the subject and subject fields and careers.

Applied Physics / 179

Thermal performance analysis of novel alternative designs for parabolic trough solar collector

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The solar parabolic trough collector is amongst the most mature solar technologies and becomes more cost-effective in recent years. We build on our previous work on hot mirrors to study an absorber with a mirrored cavity. The cavity absorber for the parabolic trough receiver is designed to reflect solar radiation back onto the absorber very efficiently, which would otherwise be lost. We built a RU in the laboratory to study the thermal performance for different designs and we companied this study with a mathematical module implemented on a simulation code. In this work, the simulation and the experiments show a good agreement, validating the applicability of the code and the proposed designs.

Physics of Condensed Matter and Materials / 180

Influence of Surface Kinetics and Induced Defects on Gas Sensing Characteristics of TiO2 nanostructures

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Over the years, a lot of researchers have invested their attention and time in investigating and improving chemical gas sensors as they have extensive applications in variety of fields such as air quality and environmental monitoring, mining, oil and automobile industry, food safety, medical diagnosis and monitoring. There is a high demand for accurate, fast, stable and portable devices that rises with technology advances and wide application fields. Enhanced sensitivity, fast response, total recovery, and good selectivity are the main characteristics of a good sensor. Titanium dioxide (TiO2) nanostructures display great potential as gas sensor due to the presence of intrinsic point defects such as oxygen vacancies (Ov) and Ti interstitials (Tii) which play a key role in enhancing the electrical, chemical and optical properties of the materials at the nanoscale. In this study, we report on the ultra-high sensitive and selective thermally treated TiO2 nanostructures synthesized via hydrothermal method. The findings displayed that as the annealing temperature increased, crystallinity improved and phase totally transformed from amorphous, anatase and pure rutile at 900 $^{\circ}$C. Moreover the morphology transforms from spherical flower-like nanostructures to rod-like structure. BET surface area decreases with temperature however the porosity improves from mesoporous to microporous structures. XPS displayed improvement in Ti3+ and F+ centres which contribute to gas sensing properties towards volatile organic compounds (VOCs) hence we proposed sensing mechanism based on surface porosity and induced defects due to lattice expansion and contraction

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Search for collective structures in ^{186}Os

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Various interpretations of the K = 2^{+} structures in the Os nuclei have been a subject of great interest in the nuclear physics community [1-3]. The nature of these structures is not fully understood. These structures could be interpreted as time-dependent gamma-vibration of a nuclear shape or as due to axial asymmetry of the nuclear shape. The current work seeks to give more insight on the microscopic nature of the K = 2^{+} bands by studying the excited states in ^{186}Os, using the ^{186}W (^{4}He, 4n) ^{186}Os reaction. The excited states in this nucleus were populated by bombarding a 150Sm target with a 47 MeV beam of 4He ions. The iThemba LABS AFRODITE gamma-ray spectrometer was used to detect the gamma-rays that were emitted from the reaction products. Angular correlation and linear polarization measurements are performed to accurately assign spins and parities to the levels of the known and new structures in ^{186}Os.

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Space Science / 182

Multi-instrument observations of atmospheric gravity waves over South Africa.

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Atmospheric gravity waves (AGWs) were observed over South Africa during the recovery phases of coronal mass ejection (CME) and corotating interaction region (CIR) driven storms on 3 Aug 2016 and 31 Jan 2017 respectively. The characteristics of the AGWs are determined from observations of intensity of the 630 nm airglow images, global positioning systems (GPS) total electron content (TEC) and SWARM electron density. The AGWs were found to be propagating in the westerly directions with velocity of 95-162 m/s. Ionosonde ionograms indicate presence of spread F with observations of AGWs which indicate Perkins instability played a role in the occurrence of spread F with AGWs as the source of the instability.

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Observations of large-scale AGWs/TIDs during enhanced auroral activity on 6 January 2014

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Observations of large-scale atmospheric gravity waves/traveling ionospheric disturbances (AGWs/TIDs) from measurements of
Global Positioning System (GPS) total electron content (TEC) and Fabry–Perot Interferometer's (FPI's) intensity of oxygen red line
emission at 630 nm measurements over Svalbard on the night of 6 January 2014 are reported here. TEC large-scale TIDs have primary periods ranging between 29 and 65 min and propagate at a mean horizontal velocity of 749–761 m/s with azimuth of 345–347 deg (which corresponds to poleward propagation direction). On the other hand, FPI large-scale AGWs have larger periods of 42–142 min. These large-scale AGWs/TIDs were linked to enhanced auroral activity identified from co-located all-sky camera and IMAGE magnetometers. Similar periods, speed and poleward propagation were found for the all-sky camera (60–97 min and 823 m/s) and the IMAGE magnetometers (32–53 min and 708 m/s) observations. Joule heating or/and particle precipitation as a result of auroral energy injection were identified as likely generation mechanisms for these disturbances.

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A case study on monitoring PID recovery on Multicrystalline modules

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Potential Induced Degradation (PID) causes a significant decrease in a module's performance and durability over its lifetime of 20-25 years. PID occurs when a potential difference between the cells and the aluminium frame cause ions to flow to the surface of the cell resulting in a leakage current. In large solar PV power plant several modules are connected in series to give desired output of between 700 to 1000 V. If earthing is not done properly a potential difference equivalent to system voltage may develop between cells and the module frame, this provides enough electric field that may cause sodium ions to migrate from the glass through to the surface of the cell into the PN junction. The polarization causes heavy shunting on individual cells resulting in decreased shunt resistance (Rsh) and increased series resistance. Environmental factors such as high humidity and increased temperature worsen the PID situation. In this work PID was induced in a module by biasing the frame of the module to positive while the negative terminal was connected to the shorted terminals of the module. The effects of this induced PID are partly reversible. The module can be left to recover naturally or a reverse polarization recovery mechanism can be applied. This paper discusses the measurement and analysis of the extent of module recovery using Electroluminescence (EL) imaging, Dark Current-Voltage (I-V) measurements and power measurements carried out before and after PID induction and at regular intervals during recovery. This shows that minor PID effects can be reversed either through natural recovery or through the application of a reverse bias. The reason for better recovery naturally may be associated with natural diffusion of sodium ions away from the cell surface and from within the PN junction defect regions. The practice of "resting" modules or changing positions of modules in a string may be advisable to manage the PID problem.

Poster Session 1 / 185

Characterization of precision 1 Ω standard resistors due to environmental conditions and power loading

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This study focuses on the recent examination of the effects of varying environmental conditions and power loading on precision 1 Ω standard resistors. The effects of temperature, relative humidity, atmospheric pressure and power loading on 1 Ω wire-wound resistance standards are described and characterized. The resistance standards are Leeds and Northrup resistors which are based on Manganin alloy. The characterization process assists in better understanding the behavior of the resistance standards and to make accurate corrections for varying environmental conditions and power loading.

Poster Session 1 / 186

Comprehensive Analysis of a Solar Measuring System and Response of Various Photovoltaic Modules and Systems

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Presented in this paper is the determination of photovoltaic (PV) module parameters for various PV technologies and their response at different operating conditions. A xenon arc lamp solar simulator characterized at the Fort Hare Institute of Technology (FHIT) was used to simulate the desired irradiance setpoints. The solar simulator was characterized in terms of its spectral match, spatial uniformity and temporal instability was carried out over a 110 cm x 129.5 cm target area, since this represents that maximum area required as dictated by the available modules. The spectral match across all wavelength intervals between 0.3 – 1.14 µm was between 0.75 – 1.25 and corresponds to class A. A spatial uniformity of 3.26% was obtained which matches a class A, and finally, a temporal instability of 3.93% obtained conformed to class B. The solar simulator's irradiance setpoint and cell surface temperature was monitored and measured via a supervisory control and data acquisition (SCADA) tool on a personal computer. Furthermore, the photovoltaic module parameters such as current, voltage, and maximum power was measured by employing a semiconductor characterization machine was compared with data provided by the PV module manufacturers at standard test conditions (STC).

Applied Physics / 187

Energy management strategy for a remote area power system in rural application

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Remote area power systems that are based on renewable energy sources have proven to be an effective way of providing energy and improve livelihoods in remote rural areas. However, the stochastic behaviour of renewable energy sources (i.e. solar) and consumption by energy users leads to a mismatch between generation and consumption. To mitigate these effects, energy storage systems such as batteries are necessary to improve the system efficiency, to store excess energy and to maintain the quality of the grid voltage during instances of power fluctuations. Therefore, an optimal energy management strategy for control and coordination of energy flows to maintain healthy battery state of charge and improve its lifetime is required.
A grid-ready microgrid system that is configured for rapid deployment in rural applications was developed and deployed at Nelson Mandela University Outdoor Research Facility. The microgrid is powered by two photovoltaic (PV) energy generators, namely, 1.57KW_p DC coupled monocrystalline silicon and 3.2KW_p AC coupled polycrystalline silicon arrays. The balance of system consists of a 5000VA EasySolar bi-directional grid forming inverter plus MPPT charge controller from Victron Energy and a Sunny Boy 3000TL grid-tied inverter (AC side) from SMA. The loads were prepared using programmable loads connected to the EasySolar inverter distribution boards and controlled using a LabVIEW program. Literature based consumption profiles of various levels (low, medium and high) for a simulated village were developed and tested on the microgrid.
In this paper, preliminary results before fully simulating the village are presented on the monitoring of the microgrid system's ability to coordinate energy flows and maintain a healthy state of charge. An investigation of the effects of different consumptions by typical household appliances on the microgrid was carried out during sunny and cloudy days. The effectiveness of a user compliance-based energy management strategy on maintaining grid integrity and a healthy state of charge was shown. In addition it has also been demonstrated that consistent remote monitoring is an effective way of managing system abuse by users.

Poster Session 2 / 188

Quantum effects in the brain: a review of possible mechanisms

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In the mid-1990s Hameroff and Penrose proposed that quantum effects played a role in the nature of consciousness. The theory, known as orchestrated objective reduction, involves proteins called microtubules, which form part of the cytoskeleton of eukaryotic cells. The theory was largely dismissed due to the fact that quantum effects were thought unlikely to occur in biological systems, which are warm and wet and subject to decoherence. There has since been some evidence that biological systems may display quantum properties, particularly with respect to photosynthesis, a process fundamental to life on earth. Quantum effects are also possibly at play in other biological processes such as avian migration and olfaction. A more recent review of orchestrated objective reduction outlines the experimental discovery of quantum coherence in microtubules. The microtubule mechanism of quantum consciousness has been joined by other theories of quantum cognition. In 2014 it was proposed that general anaesthetic, which switches off consciousness, does this through quantum means, by causing changes in electron spin. A claim supported by experiments conducted on fruit flies. In 2015 Matthew Fisher outlined a mechanism for quantum computation in the brain using Posner molecules. Even more recently it has been shown that humans can sense magnetic fields, specifically that the human brain registers changes in earth strength magnetic fields. It is possible that this effect might be mediated by the radical pair mechanism, which has been investigated in the context of birds' ability to utilise the earth's magnetic field. This review aims to investigate the current argument for the role of quantum effects in the brain and how fully the theory is supported by convincing experimental evidence.

Poster Session 2 / 189

Room temperature adsorption of ammonia gas on zinc oxide and zinc oxide–carbon nanostructures hybrid

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The absorption and desorption properties of ammonia gas on wurzite Zinc Oxide nanorods (ZnO NRs) and Zinc oxide-Carbon nanostructures (ZnO-CNs) hybrid where studies by fast acquisition x-ray photoemission spectroscopy (XPS). Chemiresistor sensors were made out of the ZnO NRs and ZnO-CNs hybrid and the sensors were exposed to ammonia gas at varies concentrations. Ammonia gas was found to chemisorb on the hybrid structure by forming amine groups while on the NRs first physisorbed on the NRs surface and then dissociates by dehydrogenation to form chemisorbed decomposition NHX species. However the chemisorption was beam induced. The hybrid showed a ~ 4.5 higher sensitivity to ammonia as compared to the ZnO NRs sensor but a slower recovery time. The enhanced response and slow desorption of the ZnO-CNs hybrid can be attributed to the strong interaction of the hybrid with ammonia gas i.e the different adsorption surface chemistry of C (chemisorption) and ZnO (physisorption), and also to the increased surface to volume ratio of the CNDs.

Physics Education / 190

Are we giving our students more than we should?

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Students' performance is the main concern of most of the lecturers and facilitators. In seeking ways to improve their understanding, a number of interventions have been employed, which include increasing contact time, employing additional tutors and one-on-one students to tutor/lecturer consultation. All of these efforts have yielded some improvements to a certain degree, but are they giving maximum output in accordance to the efforts and inputs made? In an endeavor to constantly work for maximum throughput and increased pass rate, peer teaching, students' presentations, projects and portfolios have been implemented as teaching methods and the outcomes have been assessed and analysed. Here we report on the observations of these alternative efforts of enhancing teaching, learning and understanding of concepts at the undergraduate level.

Applied Physics / 191

The potential and effect of diffusion capacitance on fast point-by-point Current-Voltage measurements of photovoltaic cells in LBIC

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The use of the Light Beam Induced Current (LBIC) measurement technique to study the spatial distribution of performance-limiting defects in photovoltaic (PV) cells is well established. The point-by-point current-voltage (I-V) measurements that are measured when scanning a light beam across a PV cell are used to extract and map comparative device and performance parameters qualitatively. The well-known capacitive hysteresis effect caused by a rapidly changing bias when fast I-V measurements are made is also observed during spot-illuminated LBIC I-V measurements. Fast I-V measurements are necessary to reduce the total LBIC scan time when more than 10 000 I-V measurements are done per square centimetre of cell area. Normally care needs to be taken to avoid erroneous parameter extractions due to this hysteresis effect. This paper details diffusion capacitance that gives rise to the hysteresis effect and its link with the density of charge carriers generated by the LBIC beam probe. The results show that in addition to extracted I-V parameters, the spatially distributed diffusion capacitance measurements may be developed as a useful tool to augment normal LBIC I-V measurements to map and identify performance limiting defects and perturbations present in PV cells.

Applied Physics / 192

Investigating the Feasibility of using Neutron Activation to Measure Elemental Pollution in the Richards Bay Area

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The Neutron Activation Analysis technique is one of the most reliable techniques that can be used to analyze various materials in all phases (solid, liquid and gaseous). According to literature, the technique (when using the traditional approach of employing thermal neutrons) is sensitive to about 78 elements of the periodic table, and can be used to simultaneously analyze up to 35 elements. In this study, the feasibility of using the technique for routine elemental pollution measurements is investigated using FLUKA simulations and experiments. The study area is Richards Bay, a town in the Nothern Coast of the province of KwaZulu-Natal. The area has various heavy industrial activities, including aluminum smelting, sand dune mining, phosphate fertilizer production, operation of a kraft process paper mill and a ferrochrome plant. Studies conducted by Masok et al. (Masok et al., 2016) found that heavy metals such as Arsenic (As), Manganese (Mn) and Cadmium (Cd) were the main water contaminants, with Mn being above the target water quality range (TWQR). The elements of interest, which are typical pollutants from the industries mentioned are Mn, Pb, Cr, Fe, Ni, Cd, Sr and Zn. In this study environmental samples and certified reference materials were irradiated using fast neutrons, their spectra were measured and analyzed. The experimental results of the water CRM showed very few peaks, excluding background, while the soil CRM showed more peaks of the activated elements, albeit with very low count rates. Among the few elements that were identified are Al, Mn and As.

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Photovoltaic array performance parameter extraction using only Maximum Power Point Traced data

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In order to observe PV characteristics, there is need for highly sophisticated and expensive equipment. These characteristics inform the user by offering a review of the state of the photovoltaic (PV) system under different weather conditions. PV Array Current-Voltage (I-V) measurements require skilled personnel, expensive equipment and isolation circuitry, which may be intricate and demanding to handle. Literature has not sufficiently shed light on how I-V parameters and thus the I-V curve can be obtained using only a small part on the curve. The maximum power point tracker (MPPT) charge controller performs its function by continuously hovering about the knee of the I-V curve and therefore the short circuit current, open circuit voltage as well as maximum power can be obtained. In this paper, MPPT data is used and then a graph is fitted onto it. The resulting PV parameters obtained are used to extrapolate and obtain the full curve. The fitted curve is compared and analyzed against the measured data. The research will pave the way into the use of the MPPT charge controller as a MPPT Performance I-V tracer.

Physics of Condensed Matter and Materials / 194

THE SYNTHESIS AND CHARACTERIZATION OF TUNGSTEN OXIDE WO3 NANOSTRUCTURES THIN FILMS FOR GAS SENSING APPLICATIONS

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Tungsten oxide (WO3) thin films for gas sensing have been successfully deposited using reactive direct current (DC) magnetron sputtering at different deposition temperatures (300 °C, 400 °C and 500 °C). The structural, morphological properties, thickness and composition have been investigated using X-ray diffraction (XRD), scanning electron microscopy (SEM) and Rutherford backscattering spectrometry (RBS) techniques. To investigate the effect of deposition temperature on the gas sensing properties of deposited thin films on alumina substrates was conducted using the Kenosistec gas sensing unit. WO3 thin film deposited at 500 °C exhibited a higher response when sensing Nitrogen dioxide (NO2) at room temperature as compared to the thin films prepared at 300 °C and 400 °C, respectively. However, as deposited WO3 thin films exhibited low sensitivity when sensing reducing gases such as hydrogen (H2) and ammonia (NH3), which was an indication of good selectivity properties of WO3 related sensors.

Poster Session 2 / 195

Electrical properties of highly oxygenated silicon diodes for radiation detection applications; overview

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Defects in silicon are intentionally introduced to improve properties of the material for fabrication of radiation detectors. These defects are introduced either by doping or irradiation of silicon. In trying to understand properties of these defects, it has been found that they interact with impurities naturally present in the silicon, oxygen, leading to a change in electrical properties of the devices fabricated from the material. It is with this reason a study on the effects of oxygen dopants is presented in this work. The study will contribute in enhancing the knowledge in defects in silicon that, in turn, open new vistas for more highly efficient radiation detectors.

Key words: silicon,defects,oxygen,electrical properties,detectors.

Poster Session 1 / 196

Monte-Carlo Shielding Calculations for a 10-MeV Electron Accelerator in Botswana

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The Botswana International University of Science and Technology is looking at the possibility of commissioning an electron beam accelerator facility for research and industrial applications. Botswana has a particular interest to sterilize meat for export as the meat industry plays an important role in Botswana's economy and represents the country's third main income earner. Additional applications of the electron beam of interest include; sterilization of single-use medical devices and pharmaceuticals, wastewater and sludge treatment, cargo screening and postal mail decontamination. We present Monte-Carlo-based FLUKA calculations to inform the design of biological shielding in compliance with the best international nuclear safety practices. In the present calculations, the shielding is designed to attenuate the biological dose rate to less than 5 μSv/h during normal operation.

Physics of Condensed Matter and Materials / 197

Simulated synthesis of Li-intercalated layered (Li2MnO3)-spinel (LiMn2O4) composite nanoarchitectures.

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The layered-spinel composites are amongst the utmost propitious cathode materials with potential to advance lithium ion batteries, to date. They demonstrate tremendous improvement on structural stability, cycling performance and higher specific capacity, > 250 mAh/g. Recent studies have focused mainly on enhancing the specific capacity of these layered-spinel composites. However, there is limited knowledge on how incorporating such layered-spinel composite electrodes affects the working voltage of lithium ion batteries. In this study, molecular dynamics (MD) method was employed to generate nanospherical layered (Li2MnO3) - spinel (LiMn2O4) composite, with different lithium concentrations. The simulations yielded crystalline nanospheres with grain-boundaries except that of Li1.6Mn2O4. RDF graphs were plotted for all systems and confirmed complete crystallisation of all structures. XRDs indicated the existence of layered Li2MnO3, spinel LiMn2O4 and spinel Mn3O4. Increases in Li-content resulted in a decrease in Mn3O4 concentration. Frenkel defects and grain boundaries were observed. The simulated layered-spinel components exist in all lithiated structures.

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Atomistic Simulation Studies of Layered Li2MnO3 Nanospherical Cathode Materials

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Li-excess Mn-based materials are potential candidates for the next generation of cathode materials owing to their high discharge capacity (>200 mAh/g). This drives the interest for the intercalation/deintercalation processes using host electrodes with dimensions at the nanoscale, as this is sufficiently quick to deliver the power required from Li-ion batteries. The favorable material Li2MnO3 is known to be electrochemically inactive in the parent bulk form, and can be rendered Li-active by leaching Li from the structure. However the structural configuration and nucleation process of Li2MnO3 have not been documented, particularly during the cycling process. The current study employs the molecular dynamics (MD) DL_POLY code to generate the nanoparticles using amorphization and recrystallization (A&R;) technique under microcanonical and canonical ensembles (NVE and NVT), respectively. Nanoparticles were deintercalated to delineate the charging process and investigate new possible Li-Mn-O intermediate phases that may emanate in the Li2MnO3 ⟶ LiMnO2 tie-line. The microstructural snapshots depict the formation of intermediate structures due to Li extraction and O loss. Furthermore, XRDs for intermediate structures shows the emergence of new peaks together with the main characteristics' peaks of the Li2MnO3. Here it is shown that structural complexity evolves during synthesis – specifically, during the nucleation and crystallization process with microstructural features such as grain-boundaries (Li2MnO3, Li1.50MnO2.5 and LiMnO2), dislocations and intrinsic point defects (Li2MnO3). Findings of this work demonstrate how the deintercalation results affect the structural transition of the Li2MnO3 cathode material, and shed valuable details about the intermediate structural transformations that transpire during cycling.

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Fabrication of inorganic quantum dots (QDs) sensitizer absorbers thermalized from lead dithiocarbamates single-source precursors complexes

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Solar cell sensitizer absorbers of inorganic quantum dots (QDs) has shown great potential in photovoltaic application. The use of quantum dots as an improved absorber layer in photochemical solar cells has attained a noble ground, where essential electron and hole generation occurs. Herein, we demonstrate the synthesis and characterization of metal sulphides nanoparticles, prepared from dithiocarbamates complexes of Pb(II) using single-source precursors technique. PbS QDs nanocrystals were measured by SEM/EDS, HRTEM, UV-Vis, PL, FTIR and Raman. Thermal studies through TGA performed in a range temperatures of (30 to 900°C). The result of HRTEM analysis revealed crystallite sizes ranges of 1.82 – 5.95. Raman spectra showed the presence of Raman active modes, while PL analysis has affirmed the presence of emissions peaks around 460 nm. Their peak of emission frequencies is very sensitive to size, shape and composition to match the solar spectrum of colours of light they absorb. This outcome features the successful preparation of single-source precursors of PbS nanoparticles.

Astrophysics / 200

Opacities to very high energy gamma rays in the blazar jets

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Some of the brightest, in electromagnetic radiation, objects in the universe are surprisingly not only stars but galaxies. Active galaxies, at their core, have supermassive black holes which accelerate charged particles along an axis. The acceleration of these particles results in various emission processes. The emission is propagated in jets whose cones lie along this axis and is observable across the entire electromagnetic spectrum at relatively high intensities. We present here the attenuation, through photon-photon pair production, of the high energy radiation (gamma-rays) of quasars as it propagates through its own low-energy ambient radiation gas (the so-called broad-line region), the cosmic x-ray background and the cosmic microwave background.

Poster Session 1 / 201

Experimental and numerical study of EIT and FWM in an ensemble of cold rubidium atoms

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Nonlinear interactions between lasers and cold atoms are of particular interest these days, as they are used to create entangled photons and control the optical properties of materials. We study two nonlinear aspects, viz. electromagnetically induced transparency (EIT) and four-wave mixing (FWM), using laser cooled rubidium. We are currently investigating entangled photon generation via FWM using a diamond configuration formed by four levels in rubidium. Two pump laser beams of different wavelengths drive the atoms from the 5S1/2 ground state to the 5D3/2 excited state via the 5P3/2 intermediate state. The atoms then return to the ground state via a 5P1/2 intermediate state. The resonant interaction between the various levels results in the generation of two additional correlated photon beams referred to as idler and signal photons. The characteristics of these additional photons are studied.

In EIT we use a lambda scheme involving two hyperfine levels at the 5S1/2 ground state and the 5P3/2 excited state of rubidium. A pump laser couples one hyperfine ground state to the excited state and a probe laser couples the other hyperfine ground state to the excited state. When the pump laser is present the cloud of atoms appears transparent to the probe and when the pump laser is off the cloud is opaque to the probe beam. We present preliminary numerical results of EIT and FWM, and give a proposed experimental setup. In addition, we provide details of the apparatus to cool the rubidium atoms.

Theoretical and Computational Physics / 202

The Coalescence Rate of Binary Neutron Stars and Black Hole-Neutron Star Systems

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When two compact objects such as black holes, white dwarfs, and neutron stars orbit a common centre of gravity, they emit energy in the form of gravitational waves (GW). The emission of GW will result in the two objects coalescing. In this work, we present the empirical calculation of the coalescence rate of binary neutron stars. We have included new important results in our input physics in order to obtain more reliable estimates of the merging time-scales. We obtain the galactic rate using a sample of known binary neutron stars and black holes in our galaxy. The galactic rate is then extrapolated to the local universe.

Poster Session 2 / 203

Comparative study of machine learning techniques in the search for dark matter candidates associated with missing transverse energy

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The Large Hadron Collider generates experimental data that consists of signal and background events. In order to further analyse the data, it is highly desirable to optimally discriminate between signal and background events. We conduct a comparative study between supervised and semi-supervised machine learning techniques in classifying between signal
and background events in $H \longrightarrow \gamma\gamma + \chi$ decay channel.

Nuclear, Particle and Radiation Physics / 204

Anomalies in the production of leptons at the LHC

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Based on a number of features from proton-proton collisions taken during data Run 1 data taking period at the LHC, a boson with a mass around the EW scale was postulated such that a significant fraction of its decays would entail the Standard Model (SM) Higgs boson and an additional scalar, S. One of the phenomenological implications of a simplified model, where S is treated a SM Higgs boson, is the anomalous production of high transverse momentum leptons. A combined study of Run 1 and Run 2 data are indicative of very significant discrepancies between data and SM Monte Carlos in a variety of final states involving multiple leptons with and without b-quarks. These discrepancies appear in corners of the phase-space where different SM processes dominate, indicating that the potential mismodeling of a particular SM process is unlikely to explain them. Systematic uncertainties from the prediction of SM processes evaluated with currently available tools seem unable to explain away these discrepancies. The internal consistency of these anomalies and their interpretation in the framework of the original hypothesis will be quantified. The potential connection with the muon g-2 anomaly is also be discussed.

Physics Education / 205

Teaching Problem Solving: The "10 Commandments" Approach

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Expertise in physics problem-solving has been identified as one of the most crucial tangible skills that a physics graduate should develop [1,2]. An important objective in physics teaching is to promote good problem solving skills. The Physics Education Research group at Rhodes University has developed a problem-solving framework which has been used to create an innovative way of teaching first-year physics. The framework incorporates a dynamic iterative process consisting of 3 fundamental tasks each consisting of a number of elements or activities that have been packaged together as a set of “10 Commandments” of problem-solving. This has led to significant structural changes to the physics first-year curriculum, where problem-solving is being explicitly taught. The project aims to evaluate the impact of the framework on students’ problem-solving cababilities

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Physics of Condensed Matter and Materials / 206

Stress-Induced Structural Changes of Lithiated Li1+xMn2O4 (0 ≤ x ≤ 1) Nanoporous Electrode Materials

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Optimising the performance potential in terms of voltage and capacity of Li-ion batteries requires understanding of both electrochemical and mechanical properties of a material. Molecular dynamics (MD) methods are capable of informing the time dependent properties such as amorphisation and recrystallisation (A+R) which can provide understanding of microstructural evolution. As such, MD simulations employing the DL_POLY code were carried out to investigate the effect of lithiation on the Li-Mn-O nanoporous materials under the NST ensemble. The Li-Mn-O nanoporous structures were obtained from spontaneous recrystallisation, during which various lithiated structures yielded to single or multigrained crystals. Furthermore, microstructural analysis depicted evolution of composites of spinel-layered components with defects. The XRDs analysis also confirmed the co-existence of spinel with layered structures owing to the characteristic/signature peaks of both polymorphs. Furthermore, the increment of Li content resulted in volume change in the nanoporous structures resulting in inward expansion within their pores. This may be ascribed to the flexible nature of nanoporous materials attributed to the hollow channels.

Astrophysics / 207

Application of the adiabatic compression scenario to the radio relic in the galaxy cluster A3411-3412

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Radio relics are non-thermal, steep-spectrum ($\alpha < -1$) diffuse radio sources found in the peripheral regions of galaxy clusters. The emission is produced through synchrotron radiation as relativistic electrons ($\gamma >> 1000$) move in helical paths through the magnetic fields of the intracluster medium (ICM). As the time it would take for the electrons to diffuse over a distance greater than 50 kpc from any compact source is longer than their radiative lifetime of approximately 0.1 Gyr, the electrons have probably been injected or (re)accelerated close to where the emission is observed. Radio relics are widely considered to have originated in intracluster shock waves, since studies have shown that relics seem to trace shock fronts. Although diffusive shock acceleration (DSA) has been widely used to explain the origin of relics, it is inefficient at low Mach numbers and other mechanisms such as adiabatic compression of fossil relativistic electrons are also present in these structures. In this project we apply the adiabatic compression model in an attempt to explain the spatial structure of the spectral index that is observed in the relic hosted in the merging galaxy cluster Abell 3411-3412.

Poster Session 2 / 208

Density Functional theory study of optical and electronic properties of (TiO2)n=5,8,68 clusters for application in organic and hybrid organic-inorganic solar cells

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A range of solution processed organic and hybrid organic–inorganic solar cells, such as dye-sensitized solar cells and bulk heterojunction organic solar cells have been intensely developed in the past two decades. TiO2 is widely employed as electron transporting material in nanostructured TiO2 perovskite-sensitized solar cells and semiconductor in dye sensitized solar cell. Understanding the optical and electronic mechanisms that govern charge separation, transport and recombination in these devices will enhance their power to current conversion efficiencies under illumination to sunlight. In this work, DFT with PBE functional computational approach was used through various computational softwares which are CASTEP, GPAW and AVOGADRO within an atomic simulation environment to explore the optical and electronic properties of three modelled TiO2 brookite clusters which are Ti5O10, Ti8O16 and Ti68O136 for application in organic and hybrid organic-inorganic solar cells. The simulated optical absorption spectrum for (TiO2)5 and (TiO2)8 cluster shows excitation around 200 nm to 400 nm but, (TiO2)8 cluster shows higher absorbance than the corresponding (TiO2)5 cluster. The density of states and the projected density of states of (TiO2)5, (TiO2)8 and (TiO2)68 clusters were computed using GPAW and PBE exchange correlation functional to further understand their electronic structure. The density of states spectrum reveals surface valence and conduction bands separated by a band gap of 1.10 eV, 2.31 eV and 1.37 eV for (TiO2)5, (TiO2)8 and (TiO2)68 clusters respectively. The projected density of states spectrum reveals 2p atomic orbitals contributing mostly to the highest occupied valence band (VB) state, whereas the lowest unoccupied state of the conduction band is mainly dominated by the contributions of titanium 3d atomic orbitals. Our findings generally shows that the optical and electronic properties of TiO2 cluster varies with the size of the cluster.

Keywords: Density Functional theory, Titanium dioxide, optical properties, electronic properties, hybrid solar cells.

Physics Education / 209

Students' approaches to solving problems kinematic problems

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The purpose of this research study is to investigate how to address the under-preparedness of students entering first year physics in South African universities, particularly with regard to their competence in solving kinematics problems. Previous studies show that the best tool for changing and expanding the conceptual understanding of a learner is problem solving; it assists a learner in dealing with new and unfamiliar concepts. These studies have also shown that cooperative learning helps students to share knowledge with each other. This research study thus investigated students' approaches in solving kinematic problems and also observed the effects of expert problem-solving approaches and cooperative learning on the performance and results obtained by students in the first-year mainstream physics at the University of the Western Cape. The findings of the study will be presented and discussed.

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The two stage test: a form of collaborative and reflective learning

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This paper reports on work that has been done in the Physics and Astronomy Department at University of the Western Cape (UWC). The mainstream mechanics physics for first years. The module focuses on improving students' success by giving them epistemological access to the study of physics. Central to the module teaching philosophy and pedagogy is the socio-cultural perspectives on learning in the sciences. This has guided the development of our intervention strategies to direct students' learning toward gaining access to the 'ways of knowing' of the discipline. Such perspectives suggest that an exclusively individual or cognitivist approach need to be complemented by those that recognize the social contexts in which science learning takes place, and which places a greater emphasis on learning as participation and identity development. This paper reports on the two-stage tests used to support physics learning. The two-stage exam is a way to encourage students' to participate and reflect on their learning by providing immediate formative and summative assessment of their learning. An overview of the mainstream mechanics physics first year module teaching and learning approach as well as the results of a survey of students' experiences of the two-stage test will be presented and discussed.

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Support program for first year main stream student outside the normal lectures and tutorial in the Department of Physics and Astronomy at the University of the Western Cape

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First year students entering the mainstream undergraduate physics program in the Department of Physics and Astronomy at the University of the Western Cape are at different level of preparedness which have impact on their learning at the university. In particular, their learning of physics which influence their retention and performance in the subject and progression in their course of choice. Findings of a survey carried out shows that most students reported that they find the physics interesting but difficult and that they needed more guidance and support in their learning of physics inside and outside the lecture periods and tutorial. In response to this, the lecturer aligned the curriculum, i.e. the teaching and learning activities to guide students learning as well as to provide a collaborative and supportive learning environment inside and outside the lecture periods and tutorial. This paper describes the initiatives implemented in the mainstream undergraduate physics program to enhance guidance and support for students learning physics outside the lecture periods and tutorial. An overview of the support program as well as the results of a survey of students' experiences of the support program will be presented and discussed

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A Case for Physics Content Knowledge and Modeling Pedagogy for Natural Science Teachers

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Negative experiences by learners at the gateway phase (grade 9 to grade 10) due to perceived uninteresting content in natural sciences or poor teaching on the part of the teachers has a detrimental effect on learners. There is evidence that many Natural Science teachers are not trained in the physics content component of the subject, Hestenes, Megowan-Romanowicz, Popp et al (2011), Chisholm (2012). This has been identified as the major factor affecting learners' achievement and interest in the sciences and thus, deterring learners from having further interest in physical sciences in the senior high school phase. Also, the curriculum structures play an important role as teachers enact their understanding of what is to be taught, and what is to be learned. The study of Natural Sciences in our high schools is a basic-foundation subject for learners who would be going on to do Physical Sciences as a matric subject. This paper focuses on the effect of a Modeling Instruction approach on Pre-Service Teachers' conceptual understanding of electricity in a PGCE science module. The modeling approach is the teaching whereby a small number of key models of the physics component are explicitly focused on and developed based on inquiry methodology, Hestenes et al (2011), Barlow, Frick, Barker, and Phelps (2014). The following questions were asked; What are the demographics of the Pre-Service teachers and the implications for the teaching of Natural Sciences? What is the effect of modeling instruction approach on teacher test scores? An analysis of test scores and a survey of teacher experience was also carried out. The results of the analysis are discussed. The findings of the study shows there is positive outcomes for modelling instruction as a strategy for teaching physics content of Natural Science to Pre-Service Teachers. The researchers recommend the use of modeling instruction for teaching the physics contents of Natural Sciences to help learners learn science better and to see the usefulness of the subject at the Junior High School level.

Physics Education / 213

The teacher development and training program for in-service teachers in the Department of Physics and Astronomy at the University of the Western Cape.

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South Africa schools have been in a state of education reform since the mid-nineties. At the core of the reform was the establishment of the comprehensive curriculum project named Curriculum 2005. Shortcomings in the Curriculum 2005 resulted in the establishment of the National Curriculum Statement in 2008. Curriculum reform as required by the National Curriculum Statement for Natural and Physical Sciences teachers implied that teachers have to have a deep understanding of the highly structured content knowledge as well as the pedagogical content knowledge to transform the content for effective teaching, in particular the physics component of the curricula. However research findings have indicated that teachers find the curriculum challenging and that they were concerned that they did not have the necessary skills to deal with the content. The South Africa Institute of Physics (SAIP) in its draft document “Strategic Plan on the enhancement of Physics Training in South Africa” recommended that Physics Departments at South Africa Universities plays a more active role in teacher development and training. This paper reports on the University of the Western Cape, Department of Physics and Astronomy’s teacher development and training program to help address the curriculum challenges teachers face in terms of the physics content and physics pedagogical content knowledge. An overview of the program as well as teachers experiences of the program will be presented and discussed.

Poster Session 2 / 215

Quantum secret sharing with graph states

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Secret sharing is an information processing protocol for managing secret information over multiple parties. The information is distributed in a way that some subset of the parties referred to as the access structure can collaborate to recover the original secret information, but all other subsets of parties referred to as adversary structure gain no information on the secret even with unlimited computing power. The parties in secret sharing forms a quantum network connected by the optical channels. In our work, we use the graph states formalism to represent the distribution of entangled states in a secret sharing protocol whereby the communicating parties correspond to the vertices and the optical channels linking them represent the edges. We also demonstrate the use of quantum repeaters which links the dealer and the players in our secret sharing scheme to address the problems associated with the imperfections in the generation of the entangled states, as well as noise and loss effects during the transfer of the states over communication network.

Poster Session 2 / 216

Effect of chemistry on the small punch creep properties of low carbon steels

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Small punch creep testing (SPCT) is a small-scale short-term (<1000h) test that can be used to determine the remaining life of power plant materials. The mechanical property data generated by this new technique needs to be correlated to more established testing techniques such as uni-axial creep testing and ultimately to predictions regarding the remaining service life of the plant component. In this study, we investigated the microstructure-to-property relationships of service exposed low carbon steels with the view to understand the deformation mechanisms operating during this accelerated test. SPCT were performed on 80 samples taken from an industrial steam-line that operated at 425 °C. The chemical composition of the extracted samples was measured using wet-chemical analysis to quantify the minor elements of carbon and manganese, as well as trace elements (P, Si, Cr, Mo, Ni, Cu, Al). In addition, graphite formation in the samples was quantified using 3D X-Ray Tomography. The quantitative data consisting of the creep-life, chemical composition and graphite content were analysed using Pearson’s correlation, exploratory factor analysis and Bayesian neural networks to determine the relationships between the different variables. The results of the statistical analysis show that carbon and manganese are strongly positively correlated (>0.50) with creep-life, while graphite content showed no relationship with the creep-life measured using SPCT. The graphite content (>0.50) was strongly positively correlated with both aluminium and silicon content. Future work will include quantitative microstructural characterisation of the samples, in order to confirm the proposed deformation mechanisms.

Physics of Condensed Matter and Materials / 217

Magnetic properties of a distorted Kagomé lattice: Gd3Os4Al12

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R-T-X (R= rare-earth, T= Transition element and X = p-block element) ternary intermetallic compounds have drawn considerable attention for their diversity of structural and magnetic properties. The rare-earth family of R3T4X12 type is of particular interest among intermetallics because the structure contains layers as well as triangular and distorted Kagomé lattice features. In this work, we have synthesized the Gd3Os4Al12 compound by arc-melting technique. The powder X-ray diffraction spectra with a full-profile refinement confirm that Gd3Os4Al12 crystallizes in the hexagonal Gd3Ru4Al12-structure type with space group P63/mmc. The temperature (T) dependent dc-magnetic susceptibility (E) reveals that the compound undergoes ferro- to antiferromagnetic orderings below 30 K. They are consistent with the phase transitions observed in the specific heat data. The (T) data obey the Curie-Weiss law above 180 K, with the calculated effective magnetic moment μeff = 7μB/Gd, which is slightly smaller than the trivalent free-ion value for the Gd ion of 7.9 μB. The obtained positive paramagnetic Weiss temperature indicates the presence of strong ferromagnetic interactions. The study may contribute towards a better understanding of the physics in Kagomé structure compounds, since in a frustrated lattice system such as this there are strict constraints imposed upon the magnetic order parameter.

Poster Session 2 / 218

Large magnetocaloric effect in RE2NiSi3 with RE = Dy and Tm

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The intermetallic ternary compounds Dy2NiSi3 and Tm2NiSi3 crystallize in the AlB2 type of hexagonal structure with the space group P6/mmm. The magnetic properties were studied by measuring magnetization as a function of temperature (χ(T)), magnetic field (M(H)) and heat capacity (Cp(T)) in magnetic fields up to 7 T. Temperature dependent magnetization and heat capacity results revealed that Dy2NiSi3 shows an antiferromagnetic ordering with Néel temperature at around 5.9 K while Tm2NiSi3 does not show any transition above 2 K. The magnetocaloric effect (MCE) of the two compounds have been evaluated from isothermal magnetization (M(T,H)). Maximum values of isothermal magnetic entropy change (−ΔSM) and adiabatic temperature change are found to be 20.9 J/kg-K and 11.4 K respectively for Dy2NiSi3 and 21.7 J/kg-K and 13.4 K for Tm2NSi3 for a field change up to 7 T.

Poster Session 2 / 219

Structural stability and electronic properties of bulk, monolayer and bilayer PtX_2 (X = Se and Te)

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Platinum dichalcogenides $PtSe_2$ and $PtTe_2$ crystallise in layered structures. We present density functional theory calculations of the structural, stability and electronic properties of the layered bulk, monolayer and bilayer platinum dichalcogenides $PtSe_2$ and $PtTe_2$ compounds in the CdI_2 structure, space group $P\bar{3}m1$. Our calculations revealed that these compounds are mechanically and dynamically stable. The investigation of electronic properties shows that monolayer and bilayer $PtSe_2$ and $PtTe_2$ are indirect band gap semiconductors while the bulk structures are a semi-metals. The calculated band structure shows that the band gaps decrease when the number of layers increase, which allows band gap engineering for optimal photovoltaic applications.

Theoretical and Computational Physics / 220

Analytical and Numerical Approaches to the quantum optical implementation of Open Quantum Walks

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Open quantum walks (OQWs) have been introduced as a type of quantum walks which are entirely driven by the dissipative interaction with external environments and are defined in terms of discrete completely positive maps on graphs [1]. In my talk, I shall give a brief overview of the microscopic derivation of OQWs [2] and propose a single atom quantum maser scheme [3] that to implement OQWs.
The structure of the proposed scheme is as follows: We consider a low-intensity flow of two-level atoms through a high-quality single mode resonator (Q~10^12) [3]. We assume that the atom-field interaction time is much shorter than the cavity damping time so that the relaxation of the resonator field mode can be ignored while an atom is inside the cavity. While an atom flies through the cavity, the Jaynes-Cummings Hamiltonian describes the coupled field-atom system, and during the intervals between successive atoms, the evolution of the field is governed by the master equation of a damped harmonic oscillator. Using the small unitary rotations approach and rotating wave approximation the effective dynamics of the system is shown to be an OQW.

Keywords: Open quantum walks; quantum optics; quantum dynamics engineering.

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Poster Session 1 / 221

Daylight Availability & Energy Savings Potential in an Office Building in Alice

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The commercial sector represents the third highest energy consumers in South Africa with electric lighting constituting one of the major energy usages in the sector. Considering the significant amount of solar radiation in South Africa, office buildings can utilise daylighting solely for daily tasks without compromising occupant visual comfort; thus, reducing the overall energy consumption in the sector. This study aims to investigate the daylight availability and the resultant potential energy in an office building. In this regard, photometric sensors were used to monitor illuminance in selected offices to illustrate the daylighting of the building. Daylight uniformity in each of the office was determined by handheld photometric meter, measured at 0.5 m interval from the windows to the interior of the office. The indoor illuminance measurements were accompanied by ambient horizontal illuminance and solar global horizontal radiation observations. Preliminary results show that the average illuminance at the work plane in the office space with all electric lights on and without daylight was 460 lux. The average daylight illuminance on a typical clear sky and overcast days was found to be 910 and 170 lux, respectively. This resulted in a daily cumulative energy savings of 11.14 kWh on a clear sky day and 0.47 kWh on an overcast day. Based on the findings of the study, daylight practice in office buildings has the potential of reducing energy consumption without compromising occupants' visual comfort. However, integration of adjustable photocell switch controller in daylight assisted office space is recommended for effective performance.

Poster Session 2 / 222

Differential Privacy Mechanisms for Gentle Measurement

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Differential privacy is a robust definition of privacy that provides mathematical guarantees to participants in a statistical database that their privacy would not be compromised. It has its roots in the field of theoretical computer science. It has since proven to be a golden standard of data privacy. Recently, the connection between this privacy framework and quantum information science has been explored. In this work, we analyze and explore the connection between differential privacy and gentle measurement, using two differential privacy mechanism, namely; Exponential and Poisson-Binomial mechanisms. The results obtained from this work provide evidence for viability of investigating the connection between differential privacy mechanisms and gentle measurement.

Physics of Condensed Matter and Materials / 223

Structural analysis of Ti/LiCl at different temperatures

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In this study we explore an alternative way to maximize Ti production by using LiCl salt. We employed the DL_POLY code to understand the interaction of LiCl at various temperatures in order to achieve Ti that has good properties at high temperatures. The LiCl structure was validated using available experimental and ab initio structural data such as elastic constants. The molecular dynamic results of LiCl show that the simulation used is a reliable model of a bulk alkali halide and this model is sufficient to set an environment that will allow to investigate the evolution of titanium. Furthermore, the RDF's of the Ti/LiCl structure depict a change in the morphology of the system for all interactions as the temperature is increased. The results of this study might give us more insight on the growth of titanium in salt mediums and on whether this salt can possibly be used to maximize Ti production.

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Effect of annealing at different time interval on the structure, morphology and optical properties of MgAl2O4:0.1% Mn2+ nanophosphors

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In this study, manganese doped magnesium aluminate nanopowders (MgAl2O4:0.1% Mn2+) were prepared by citrate sol-gel. The effect of annealing period/time (AP) at a fixed annealing temperature (800 oC) and dopant concentration (0.1% Mn2+) on the structure, particle morphology and photoluminescence properties of the nanopowders were investigated. X-ray powder diffraction (XRD) results showed that the crystalline quality and crystallite sizes of the powders were not influenced by varying the AP. Doping with 0.1% Mn2+ did not influence the crystal structure of the un-doped material. The scanning electron microscope (SEM) images suggested that doping and AP does not influence the particle morphology of the nanopowders. Transition electron microscopy (TEM) image suggested that the crystallite sizes were in the nanoscale. Photoluminescence (PL) results showed two emission peaks located at around 413 and 655 nm respectively. The 413 nm emission peak is attributed to the defects level within the un-doped material. On the other hand, the 655 nm emission peak is attributed to the ($4T1 \longrightarrow 6A1$) transitions of Mn2+. The CIE coordinates results showed that the emission colour change from bluish to the violet region when increasing AP.

Applied Physics / 225

Material composition and thermal analysis of bunker gears used by firefighters in the City of Johannesburg

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Firefighters are constantly exposed to open flames and extreme heated conditions during fires and as a result use firefighting protective clothing (bunker gear) for protection. Firefighting protective clothing derives its heat withstanding strength from the flame retardants added in the manufacturing process. However, some flame retardants, including chlorinated and brominated flame retardants, have been found to be harmful to humans and the environment. Five (5) new and three (3) used bunker gears used in the City of Johannesburg were investigated and found to contain brominated flame retardants (BFRs), particularly polybrominated flame retardants (PBDEs) and hexabromocyclododecane (HBCDD). X-ray fluorescence (XRF) scanning measurements showed that all the samples contained significant amount of BFRs. Bromine content in the XRF ranged from 444 to 20 367 µg/g. Gas Chromatography-Mass Spectrometer (GC-MS) was used to validate the XRF results. BFRs, particularly PBDEs and HBCDD, were detected in all samples with concentrations ranging from 261.61 to 1001.77 µg/g and 0.01 to 0.07 µg/g, respectively. The flame retardants' impact on thermal performance of the garments was investigated using the Cone Calorimeter under 50 and 75 kW.m-2 external heat fluxes. Measured Cone Calorimeter parameters were used to model indices such as the fire growth rate (FIGRA). The average FIGRA was found to be 1.88 ± 0.44 kW.s-1 (5 new bunker gears) and 2.63 ± 0.37 kW.s-1 (3 old/used bunker gears) for external irradiation flux of 50 kW.m-2. Smoke growth rate (SMOGRA) of the bunker gears were 3.12 ± 0.34 and 4.96 ± 0.59 m2.s-2, respectively for new and used gears under 50 kW.m-2 irradiation and 13.26 ± 3.63 and 14.60 ± 2.37 m2.s-2 under 75 kW.m-2 heat fluxes. Further links between the fire retardants and the measured thermal parameters will be presented.

Poster Session 1 / 226

The Description of Exclusive Proton-Proton Knockout Reactions from Unstable Nuclei Within a Relativistic Framework.

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In this project we study exclusive proton-proton scattering reactions from unstable nuclei at intermediate energies (100 - 500 MeV) using relativistic formalism. The original relativistic impulse approximation (A1) and generalized relativistic impulse approximation (A2) formalisms are used to calculate the optical potentials, with target densities derived from relativistic mean field theory using QHD I, QHD II, NL3 and FSUGold parameter sets. Furthermore, comparisons between the optical potentials are undertaken using both IA1 and IA2 formalisms, and the different RMF Lagrangians are presented for both stable and unstable targets. The study of the effect of full folding versus factorized form of optical potentials elastic scattering observables (especially spin observables) is undertaken as well. The experimental work to verify the theoretical studies/results is performed at the iThemba laboratory for Accelerator Based Sciences (Faure, South Africa).

Applied Physics / 227

Sizing optimisation and installation of a stand-alone PV water pumping system for irrigation

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To deal with the shortage in electricity and high diesel costs affects the pumping requirements of community water supplies and irrigation; so using solar energy for water pumping is an alternative to conventional electricity and diesel based pumping systems. Solar water pumping is based on photovoltaic (PV) technology that converts solar energy into electrical energy to run a DC or AC motor based water pump. The use of such a system is appropriate since there is a natural relationship between the availability of solar energy and the water requirement. The current study seeks to establish the optimal sizing and installation of a stand-alone PV water pumping system to meet the water requirements and the additional electricity load required in the farm located in Limpopo Province. The water was pumped by the submersible pump rated at 5.5 kW from the borehole with capacity of around 15 000 L/h powered by 18 solar panels with a power rating of 350 W for a total of 6.3 kWp. The mathematical model to determine the relation between water flow rate and PV power will be matched with the data obtained experimentally for future performance predictions in other locations. Furthermore, the performance of the system was verified in terms of meteorological data.

Poster Session 2 / 228

Effects of Gadolinium dopant on electrical characterization of p-type Silicon diodes

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Abstract: The aim of this paper is to improve the radiation-hardness of silicon diodes. The schottky diodes were fabricated on undoped and gadolinium doped p-type silicon. The electrical properties of the diodes were studied using the current-voltage (I-V) and capacitance-voltage (C-V) techniques. The results show that the silicon diodes have become relaxation-like after doping hence the device shows Ohmic behaviour. This is in concurrence with the presence of the 'midgap defect' in gold and platinum doped devices from literature [1-4]. Erbium and niobium doped silicon have been found to have similar results as gold and platinum. Relaxation material is radiation-hard since the effects of radiation on the device are suppressed. From the preliminary results gadolinium doped silicon shows Ohmic behaviour which has been found to enhance the performance of the diodes in radiation-hard particle detectors.

Keywords: Silicon, gadolinium doped diodes, I-V and C-V, radiation-hard.

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Poster Session 2 / 229

Exploration of intermediate phases that form during lithium and oxygen extraction from the Li2MnO3 nanoporous cathode material

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Li2MnO3 has been classified as an active intercalation host material for lithium ion batteries (LIBs) due to its large specific capacity. However, its degradation nature reported to be due to oxygen loss and phase transformation during cycling hinders its practical application. Furthermore, the mechanism behind the degradation has not been fully understood. As such, studying the crystal growth process of these intermediate phases during charging is of great significance. In this work the simultaneous removal of oxygen and lithium from the nano-Li2MnO3 will be studied in a quest to explore the formation of different intermediate structures. Molecular dynamics simulations was used to carry out the spontaneous crystal growth of the nanoporous structures. The NVE ensemble was used in amorphisation and NVT for recrystallisation during the crystal growth. Our results reveal highly defective structures which are vacancy driven, and the atomic substitutions are noted in the layers. Furthermore, the XRDs and microstructures reveal the formation of layered and spinel-type structures as the lithium and oxygen content decreased.

Poster Session 1 / 230

Facile microwave hydrothermal synthesis of nickel sulphide- reduced graphene oxide composites

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The harmful and life-threatening properties of methane (CH4) and carbon monoxide (CO) gases at low temperatures has led to extensive research for suitable detection. Semiconducting metal oxides (SMOs) have been thoroughly studied in sensing due to their favourable characteristics, for instance, their low cost, long lifetime, fast response time and high sensitivity [1]. Nonetheless, the practical application of these materials is limiting because they operate at high temperatures, have poor recovery and limited selectivity [2]. Researchers are currently looking for materials with improved high selectivity, high sensitivity and low power consumption.

Metal sulphide composites have recently attracted much attention due to their excellent properties and their promising application in Li-ion batteries, supercapacitors, solar cells and oxygen reduction reactions (ORR) to name a few [3]. The Ni3S2 catalyst is the most stable polymorph of the nickel sulphide family. It is reported to having a room temperature resistivity of 1.8 Ω.cm, is a good conductor, and has been used for humidity sensing [4]. Reduced graphene oxide (rGO) on the other hand has a large surface-to-volume ratio and good conductivity, which can be easily tuned by increasing or decreasing the defect sites [5]. rGO has helped improve the sensitivity, selectivity and lowered the operating temperatures of SMOs.

In this work, a green, simple and affordable microwave hydrothermal technique was employed for the synthesis of nickel sulphide -reduced graphene oxide composites. Sequential addition of metal precursors, wt % of the catalyst and time study were conducted. The morphological, structural and chemical properties were sufficiently characterized using transmission electron microscopy (TEM), scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS), x-ray diffraction analysis (XRD), Raman spectroscopy, Fourier transform infrared (FTIR) spectroscopy, Ultra Violet-Visible spectroscopy (UV-vis), photoluminescence (PL), Brunauer-Emmet-Teller (BET) surface area analysis and thermogravimetric analysis (TGA). From SEM analysis, we noticed quasi-spherical nanosized particles on the rGO sheets with a crumpled structure. During the time study, we observed a difference in the particles on the rGO sheets. At 4 minutes, the nickel sulphide appears as layered, irregular flaky particles. As time increases the layered structures form quasi-spherical nanosized seed like structures with a rough surface. At 10 minutes, the seed like structures has a smoother and more ordered quasi-spherical morphology.

[1] Sh. Nasresfahani, M.H. Sheikhi, M. Tohidi, A. Zarifkar, Materials Research Bulletin 89, 161–169, (2017).
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Poster Session 1 / 231

Microwave hydrothermal synthesis of nickel sulphide- reduced graphene oxide composites

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The harmful and life-threatening properties of methane (CH4) and carbon monoxide (CO) gases at low temperatures has led to extensive research for suitable detection. Semiconducting metal oxides (SMOs) have been thoroughly studied in sensing due to their favourable characteristics, for instance, their low cost, long lifetime, fast response time and high sensitivity [1]. Nonetheless, the practical application of these materials is limiting because they operate at high temperatures, have poor recovery and limited selectivity [2]. Researchers are currently looking for materials with improved high selectivity, high sensitivity and low power consumption.

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In this work, a green, simple and affordable microwave hydrothermal technique was employed for the synthesis of nickel sulphide -reduced graphene oxide composites. Sequential addition of metal precursors, wt % of the catalyst and time study were conducted. The morphological, structural and chemical properties were sufficiently characterized using transmission electron microscopy (TEM), scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS), x-ray diffraction analysis (XRD), Raman spectroscopy, Fourier transform infrared (FTIR) spectroscopy, Ultra Violet-Visible spectroscopy (UV-vis), photoluminescence (PL), Brunauer-Emmet-Teller (BET) surface area analysis and thermogravimetric analysis (TGA). From SEM analysis, we noticed quasi-spherical nanosized particles on the rGO sheets with a crumpled structure. During the time study, we observed a difference in the particles on the rGO sheets. At 4 minutes, the nickel sulphide appears as layered, irregular flaky particles. As time increases the layered structures form quasi-spherical nanosized seed like structures with a rough surface. At 10 minutes, the seed like structures has a smoother and more ordered quasi-spherical morphology.

[1] Sh. Nasresfahani, M.H. Sheikhi, M. Tohidi, A. Zarifkar, Materials Research Bulletin 89, 161–169, (2017).
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Poster Session 1 / 232

Fire performance properties of South African commonly used hardwood

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The effect of fire or heat and the associated fire hazards of South African hardwoods had been minimally researched. Full combustion is normally accompanied by ‘high’ temperatures, ‘fast’ fire/flame spreads with associated ‘high’ heat release rates as well as smoke and toxic gases. Quantitative investigations on these fire performances of selected and common South African hardwood species that include Stinkwood (ocotea bullata), Tamboti (Spirostachys Africana), Real yellowwood (Podocarpus latifolius) and Leadwood (Combretum imberbe) have been undertaken using the Cone Calorimeter and the Thermogravimetric analysis instrument. In terms of critical heat flux needed for ignition values measures were: lead wood (3.35 kWm-2); Stinkwood (4.51 kWm-2), Tamboti (10.43 kWm-2) and Real yellowwood (18.1 kWm-2). The fire growth rate (FIGRA) in (kW.s-1) were: lead wood (1.39); Stinkwood (5.22), Tamboti (3.30) and Real yellowwood (3.13). The smoke spread rate (SMOGRA) in (m2.s-2) were: lead wood (1.1x10-4); Stinkwood (2.1x10-4), Tamboti (3.7x10-4) and Real yellowwood (6.92x10-5). The activation energy (in kJmol-1) as well as pre-exponential factors (in s-1) for the woods’ decomposition were: lead wood (136.9;6.6x10+10); Stinkwood (103.7;1.48x10+8), Tamboti (207.8;2.84x10+17) and Real yellowwood (241.8;9.9x10+19).

Poster Session 1 / 233

Development of Tandem Perovskite Solar Cells

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In the recent past, the perovskite materials have shown remarkable performance as one of the most promising materials for photovoltaic applications. This is mainly due to the material’s excellent light absorption and suitable carrier diffusion lengths, resulting in high device efficiencies with significant opportunities to realize low-cost technology. This study aims investigate the development of perovskite solar cells in tandem with silicon-based solar cells. Inorganic perovskite oxides and halide materials will be used to prepare hybrid organic-inorganic thin films. Using the one-step and two-step methods the films are deposited onto a silicon-based solar cell. To assess the quality of the solar cells photoluminescence will be used to estimate the minority carrier lifetime. Higher carrier lifetime result in improved open-circuit voltages. The current-voltage measurements are performed on the perovskite tandem solar cells.

Physics of Condensed Matter and Materials / 234

Assessment of Remaining Life and Microstructure Degradation of Creep Exposed High – Pressure Rotor Steels

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A remaining life assessment and microstructural ageing study was performed on a high-pressure turbine rotor belonging to a 200 MW coal-fired power plant unit. The rotor consists of 1CrMoV steel that operated for more than 100 kh, under a pressure of 10.55 MPa and a temperature of 520 °C. Core samples were removed from the high stressed geometry areas of the rotor by a plug sampling and hydro – pillar repair welding process. Light microscopy was used to map out creep voids and cracks which form as a consequence of the reduction in creep-strength due to microstructural degradation. Hardness testing was performed to estimate the extent of damage undergone by the rotor. Two methods were used for estimating creep remaining life; creep – cavitation model and a hardness based model. Furthermore, scanning electron microscopy and transmission electron microscopy techniques were used to quantitatively evaluate the microstructural ageing to corroborate the results for accumulated creep damage obtained based on the creep void and hardness measurements.

Space Science / 235

Long-term cosmic-ray modulation: a multi-decade approach

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A simplified ab initio approach is followed to model cosmic-ray (CR) modulation from first principles, using a novel time-dependent three-dimensional stochastic solver of the Parker transport equation, taking into account the various processes that modulate the intensities of these cosmic rays on their way to the inner heliosphere, and thus to Earth. This approach focuses on the effects of temporal changes in both the larger scale quantities such as the heliospheric magnetic field, heliospheric tilt angle and the solar wind, and in the small scale quantities such as the magnetic variance and and correlation scales, on computed CR intensity spectra. This study systematically demonstrates how salient features in cosmic-ray modulation arise due to changes in these quantities

Physics Education / 236

Physics student teachers' perceptions, experiences and their assessment of the teacher education programme. A case study of one South African University

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An investigation aimed at identifying and explaining physics student teachers' perceptions, experiences and their assessment of the teacher education programme at one of the South African University was done. The main objectives of the study included, to assess the student teachers' expectations when joining the programme. Student teachers' experiences as they progress in their teaching programme were identified. Their views on how to improve the teachers' education program for physical science teachers are of great importance.
A qualitative approach was used to collect data using open ended questionnaires and focus group discussion. The outcome of this study shows that student teachers trainees do not receive adequate and appropriate preparations from high school. Their home faculty does not effectively allow them to get a good training to teach physical science at high school level.

Physics of Condensed Matter and Materials / 238

Perspectives on the Crystal Growth of Oxygen and Manganese Compensated Li-Rich Layered Nanoparticles

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The charge compensation of both transition metal (Mn) and oxygen in the redox reactions has driven possession of high specific capacity in Li-rich layered oxide. Although these Li-rich electrodes could achieve higher reversible capacity in energy storage systems due to the oxygen anion participating in electrochemical reaction, that is not the case because of the irreversible oxygen reaction that occurs during the initial charge cycle, resulting in structural instability due to oxygen evolution and phase transition. This study shows the impact of transition metal and oxygen compensation during nucleation and crystal growth of layered nanospherical particles. Snapshots for the Mn-compensated nanosphere display a multi-grained crystal with grain boundaries and clusters of Li-O. On the contrary, the oxygen-compensated nanosphere resulted in single crystals with minimized oxygen loss. Microstructures derived from the oxygen compensated structure illustrate domination of layered $LiMnO_2$ polymorph whilst the loss of oxygen in Mn-compensated nanostructure promotes formation of a spinel phase owing to Mn^{3+} atoms migrating to the Li-layers. Understanding such reactions will contribute immensely to the design of high capacity lithium ion batteries for large scale applications.

Physics Education / 239

A re-look at the sequence of concepts in our curriculum

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The concepts and topics in introductory first-year physics textbooks are arranged in a certain manner of which has been traditionally followed in delivering lecturers. These topics and concepts help to strengthen students' critical thinking and problem-solving skills while introducing them to many topics they will learn in more details in later modules in physics. Most often, mechanics topics are following the traditional norm, in fact, this curriculum sequence has not been altered in decades. After a number of observations and studies into the understanding and assimilation of some first year important topics such as vectors, there was a need to re-look at the lecturing sequence. Is there a reason for this? There are many other questions that arise pertaining to these mechanics topics in physics. These questions include: Does taking the mechanics' module sequence "out of order" have an impact on student learning in physics? What topics should be taught first? When should these topics be taught? This paper will address some of these questions by looking at students' performance in the mechanics' module and qualitatively using open-ended questionnaires.

Physics Education / 240

An evaluation of the impact of scientific explanation model on pre-service teachers' understanding of basic concepts in electricity

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Electricity as a topic is regarded as challenging worldwide because students from different countries around the world are reported to have the same pattern of learning difficulties in understanding electricity due to misconceptions associated with it. The literature on misconceptions suggested further research to determine if instructors are able to prescriptively address students' misconceptions in such a way that learning is improved significantly and also if teachers are gathering insights into students' preconceptions and thought processes. The understanding of students' preconceptions and thought processes is believed to be helpful in planning for future interventions. As an attempt to bridge the conceptual gap in students' understanding of basic electric circuits, literature advised university lectures to pay more attention into students' misconceptions by developing instructional strategies or materials that will enhance students' understanding. In bridging the gap, a two-tier test was developed guided by selected designed principles adopted from knowledge building theory. The current study explored the impact of the scientific explanation model as an instructional strategy, on bridging the conceptual gap about some basic concepts of the DC circuit.

Physics Education / 241

Inquiry based learning in Optics : Study of students' understanding of image formed by a converging lens and concave mirror.

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Both the lens and mirror formulae have the same mathematical representation, thus student assume same physical principles to explain image formation in lens and mirrors. Although students tend to correctly apply the formulae in solving problems on
mirrors and lenses, they usually experience significant difficulties and misconceptions regarding the formation of an image by a converging lens or a concave mirror because of
their inability to transfer information from one domain to a new different situation. Traditional lecture methods have shown to have limited effectiveness in improving student conceptual understanding in basic Physics courses. The purpose of this study was to investigate students' understanding of image formed by a converging mirror and converging lens using an inquiry based method, a approach which is credited as a highly
effective method of instruction and is gaining worldwide recognition because it encourages students become co-creators of knowledge as active participants in the learning process. In
order to achieve the objective of this investigation, a pilot study was undertaken with registered students studying Physics at a university of technology in SA. The students were divided into two groups (experimental and control) and null hypotheses hypothesis were tested. Inquiry-based instructed students performed significantly better than those the instructed by the traditional lecture method thus the inquiry based learning proved to be a more effective method than the later.

Key words : converging lens, image, inquiry based learning, lecture method

Astrophysics / 242

Unifying the Background with Perturbations in Chaplygin-gas Cosmology

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Recently a generalized Chaplygin gas has been proposed as a unifying solution to the dark energy and dark matter problems. In this work, we will study the density perturbations of a universe filled with radiation, baryonic matter and the Chaplygin gas fluid and analyse the implications on large-scale structure. We will then compare our model results with power spectrum of the observable universe.

Poster Session 1 / 243

The Performance and Degradation Analysis of different PV technology at different climatic regimes in South Africa

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Abstract
Novel methods of energy production (clean, inexpensive and abundant) are steadily replacing the conventional and out-dated methods (toxic, high-cost and rapidly depleting). Photovoltaics, in particular, show a relentless incline in the global contribution to electricity production. South Africa experiences large solar energy, the core of PV application, yet its contribution to PV power production significantly lags behind many low solar resource countries. To effectively exploit this abundant natural resource, the nature of solar radiation and the performance of PV technology must be well-documented and well-understood. Due to its shortage, this paper focuses on the latter.
PV performance depends on the solar cell material and the PV system environment. Despite this, manufacturers characterize PV performance under the non-representative standard testing conditions (25 °C, 1 kW/m^2 and AM1.5) that overestimate performance. To accurately characterize PV performance, analysis must be conducted under the actual outdoor conditions of the site of installation. The most appropriate PV technology can then be deployed at the most appropriate location for maximum solar energy harvest.

In this work, the performance of high-efficiency PV technology (CdTe and pc-Si) at the coastal (Port Elizabeth) and inland (Vuwani and Johannesburg) areas of South Africa is analysed and compared. This work uses DAQ system-controlled ground stations to collect, transmit and permanently store time-averaged solar resource and meteorological data over 1-minute, hourly and daily intervals. Also, the PV systems under analysis use mppt of a data logger to collect, transfer and store PV performance data. MATLAB software is finally used to analyse and compare PV performance.
Due to its lower dependency on spectral effects, pc-Si is expected to perform best in P.E. (coastal area). Due to its lower dependency on temperature, CdTe is expected to perform best in Vuwani (inland area).

Poster Session 2 / 244

Effect of Co addition on the structural, electronic and magnetic properties of Fe16N2 employing first principles approach

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Improvements in energy efficiency and reduction of greenhouse gas emissions have been some of the central topics in recent years in environment and climate change. The advantages of using permanent magnets in many different types of electromagnetic drive and static magnetic field applications are compelling. It seems demand is bound to increase substantially in coming years. There are significant challenges associated with coming up with new alloys or composite materials that can be used for bulk permanent magnets with an energy product in excess of 460 kJ m−3. In this study, first-principles approach employing the density of states within the generalised gradient approximation is employed. The structural, electronic and magnetic properties of Fe16-xN2Co for the development of permanent magnets are investigated. Firstly, geometry optimization was performed to reach the equilibrium state of the structures and the results compared well with the available experimental results. Interestingly the density of states at the Fermi level decreases suggesting the stability of Fe16N2 with Co addition.

Theoretical and Computational Physics / 245

Non-repeating Open Quantum Walks

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A model of a non-repeating quantum walk is formulated in 2D using the formalism of Open Quantum Walks (OQWs) [1]. During the non-repeating quantum walk, the particle changes direction at every step and does not go to an already visited site. To achieve this dynamics of the walker all visited sites are recorded using a memory system. In the model which we developed “quantum coins" are composed of Kraus operators of the corresponding OQW. The non-repeating OQW is implemented using the unraveling of the corresponding master equation. Quantum trajectories for various number of steps have been generated (20-2000 steps of the walk). The distributions of non-repeating open quantum walks, non-reversal open quantum walks [2] and open quantum walks are produced using the same randomly generated coins (set of Kraus operators) and compared. It is observed that the non-repeating open quantum walks have the largest spread of all three.

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Keywords: Self-avoiding walks, quantum walks, open quantum system

Poster Session 1 / 246

Radioactivity assessment of Uranium Isotopes concentration in water sources at and near selected former uranium mines in the West-Rand area of Johannesburg

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Radioactivity from several naturally occurring and anthropogenic sources is present throughout the environment and trace levels of radioactivity are normally found in all types of drinking water. The activity concentration and composition of these radioactive constituents vary from place to place, depending principally on the radiochemical composition of the soil and rock strata through which the raw water may have passed. The focus of this Master's program will be primarily on the Uranium activity in all types of drinking water near Uranium mines.

The main goal of the project is to determine natural radioactivity concentration of uranium isotopes in the surrounding areas of uranium and gold mines. The focus of the study will be in the West Rand area of Johannesburg where primarily most of the gold mining activity is concentrated.

The first part of this study will concentrate on the discharged effluent water (from the mines) into the nearby stream or river. The same stream or river where the mine chosen for the study is discharging its effluent water; a sampling point lower down the stream or river will be chosen where there is a possibility of farming activities;

The third part will focus on analyzing drinking water from the tap in the Johannesburg and Pretoria municipalities and look at a few commercially bottled mineral water available in supermarkets in the surrounding areas in Pretoria.

The analysis will be carried out by an Alpha Spectroscopy system (Canberra) with Passivated Implanted Planar Silicon (PIPS) detector which has 12 chambers. The relative efficiency of the system on desired shelf is approximately 12% which will also be verified during the study.

Poster Session 2 / 247

Study of lattice defects in BaF2 using positron annihilation and X-ray diffraction methods at elevated temperatures

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We utilized positron annihilation technique in obtaining Doppler broadening spectra in the temperature range 300 – 900 K. Theoretical approach utilizes the Local Density and the Generalized Gradient Approximations that calculate the Doppler broadening spectra in the temperature range. We found that the positrons annihilating with barium valence electrons, especially the 5p and the 6s electrons, contribute immensely in the electron-positron annihilation momentum density. At 693 K, the positron annihilation fraction due to Ba-atom when anion Frenkel is created, is found to be 84.44% compare to 15.56% for F-atom. We also noted that for F di-vacancy at 693 K, the annihilation fraction due to 5p and 6s valence and core electrons in Ba increases by 2.13% to 86.57%. The intensity of disordering of fluorine sub-structure is found to increase non-linearly at a temperature from 580 K without observing any appreciable conductivity. X-ray diffraction method provided a lattice constant of 0.625 nm at 693 K through which an appreciable small activity in the conductivity is first observed. This is demonstrated through the correlation between the lattice constants and the conductivity values at elevated temperatures.

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The impact of the kelvin redefinition on temperature measurements for meteorology and climatology

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All calibrations of thermometers for meteorological or climatological applications are based on the International Temperature Scale of 1990, ITS-90. Based on the best science available in 1990, ITS-90 specifies procedures which enable cost-effective calibration of thermometers worldwide. In this paper we discuss the impact for meteorology of two recent developments: the forthcoming 2019 redefinition of the kelvin, and the emergence of techniques of primary thermometry that have revealed small errors in ITS-90.
The kelvin redefinition. Currently, the International System Units, the SI, defines the kelvin (and the degree Celsius) in terms of the temperature of the triple point of water, which is assigned the exact value of 273.16 K (0.01 °C). From 2019, the SI definitions of these units will change such that the kelvin (and the degree Celsius) will be defined in terms of the average amount of energy that the atoms and molecules of a substance possess at a given temperature. This will be achieved by specifying an exact value of the Boltzmann constant, kB, in units of joules per kelvin. Thus after 2019, measurements of temperature will become fundamentally measurements of the energy of molecular motion. However, because thermometers will continue to be calibrated according to the procedures specified in ITS-90, this will have no immediate effect on the practice of meteorology.
Errors in ITS-90. Since 1990, the primary thermometry technique known as acoustic thermometry has improved to an extraordinary extent. Acoustic thermometry measurements are now capable of detecting errors in the primary thermometry used to construct ITS-90, and hence in ITS-90 itself. Over the meteorological range these errors are small but they are present in every calibrated thermometer on Earth. The errors vary approximately linearly between ≈ +0.005 K at ~ +50 °C, and ≈ -0.003 K at ~-30 °C. Errors of this magnitude are unlikely to concern meteorologists, but if there is in future a shift away from ITS-90 to a new International Temperature Scale, then the concomitant shifts in practical temperature calibrations may be just detectable by homogenisation algorithms used in climate studies.

Poster Session 1 / 250

Developing Nuclear Forensics Signatures in the Southern African Region: A case study of South Africa and Namibia

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Illicit trafficking of nuclear material has led to the International Atomic Energy Agency (IAEA), to require that all her Member States should develop nuclear forensics signatures for their Countries. These fingerprints are used to trace the origin and intent of the interdicted nuclear material.
At the Center for Applied Radiation Science and Technology, we used an NexION 2000, ICP-MS to resolve the nuclear forensics signatures from different uranium nines in South Africa and Namibia. Results show that the South African uranium (nuclear material) is significantly different from that from Namibia.
Hence it is concluded that nuclear material from these counties can be identified and attributed back. We recommend that this work be repeated in all the Countries of the Southern African Region.

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Novel Fibre Bragg Grating Based All Optical OADM for Flexible Spectrum Channel Reservation to Minimize Optical Cross Talk in WDM optical communication networks

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Flexible spectrum has been proposed as a spectrally efficient networking technology that effectively supports dynamically varying traffic demands. With the Wavelength division multiplexing (WDM) optical networks ability to provide increased capacity and efficient spectral resource utilization it can be used to reserve channels to improve the quality of service in big data transmission. Optical add-drop multiplexer (OADM) is key components for add or drop wavelengths in high bit rate optical networks providing channel reservation as a mechanism for minimizing optical cross talk. In this work, a Fibre Bragg Grating based OADM was developed and functionality was experimentally demonstrated for an OADM configured from an FBG fibre and two circulators. The vertical-cavity surface-emitting laser (VCSEL) was transmitted along the FBG engraved fibre as it can be tuned to lase at a wavelength satisfying the Bragg Conditions. as the FBG is mainly used in sensor application with less stringent requirements and in WDM systems the wavelength is specified. The OADM performance measurement in a 25 km single mode fibre transmission line, for 3 × 50 GHz channels wavelength division multiplexing (WDM) network are reported. Results show that quality of service measured as Bit Error Rate (BER) of the proposed OADM channel reservation are lower and provided better performance than the existing WDM optical networks. Furthermore, the OADM fulfils the full width at half maximum (FWHM) requirement for wavelength-division multiplexers (WDMs) according to the International Telecommunication Union (i.e., FWHM < 0.4 nm).

Poster Session 2 / 252

Geometry and Electronic Properties of TinPt (n = 2–7) Clusters: A Density Functional Theory Study

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Nanoscale clusters are considered a new phase of matter, being the bridge between atoms and the bulk. They form part of extensive research due to their various potential applications. There is considerable interest in the structures and properties of nanoscale clusters, for example, being used as finely divided metal catalysts, particularly for bimetallic clusters, which offer the opportunity of tuning their activity and selectivity. To date, much work has been concentrated on small clusters of late transition metals™, namely, noble and platinum metals, while little has been done for the early transition metals. Among TM clusters, the reactivity of titanium clusters is not fully understood due to the complexity of the almost empty d band, which provides unique bonding properties. In this study, we investigate the structures and electronic properties of TinPt (n = 2–7) clusters using density functional theory with the generalized gradient approximations (PBEsol and PBEsol0). The stability of the clusters is also studied whereby the consistency of TinPt (n = 2-7) clusters with pure Tin (n = 2-7) clusters is considered. PBEsol was found to be overestimating the energies of the clusters.

Theoretical and Computational Physics / 253

Extensions of THERMUS and its Applications in High Energy Particle collisions

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We have analyzed and discussed the hadronic abundances measured in Au-Au, p-p and Pb-Pb collisions at RHIC and LHC experiments using THERMUS. The results were obtained with two particle data tables, and their differences were explained. In particular, the data from the RHIC experiment for Au-Au collisions at 130 GeV and 200 GeV were discussed and analyzed. Similarly, using the preliminary particle yield results of p-p collisions at 0.9 TeV and 7 TeV as well as Pb-Pb collision at 2.76 TeV particle yield calculations were presented and the thermodynamic parameters were obtained from the fits.

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Growth of Silicon Carbide nanoparticles by thermal annealing of e-beam deposited SiC/Pd thin films on c-Si substrate

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Silicon Carbide (SiC) nanostructures are well known for their superior mechanical properties, high thermal conductivity, low thermal-expansion coefficient, good thermal-shock resistance, chemical stability, and electron affinity which make them excellent candidates for work in harsh environments [1]. Silicon carbide nanoparticles were grown via thermal annealing of electron-beam deposited SiC/Pd thin films on crystalline silicon (c-Si) substrate in vacuum at 800 0C. Scanning electron microscopy (SEM) analysis of the as-deposited samples showed a uniform surface with small grains while annealed films showed formation of islands that grew larger as SiC thickness increased. Rutherford Backscattering Spectrometry (RBS) and Energy-dispersive X-ray Spectroscopy (EDX) confirmed the presence of Pd, Si, C and O on the nano-islands. Fourier Transform Infrared Spectroscopy (FTIR) confirmed the 3C-SiC polytype.

Space Science / 255

An investigation into sources of pc5 pulsations during quiet geomagnetic conditions

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Pc5 pulsations are global magneto-hydrodynamic events in the magnetosphere. We investigate quiet-time Pc5 pulsation events and their likely excitation mechanisms using SuperDARN, and Omni and GOES satellite data. With the interplanetary magnetic field (IMF) Bz northward, we investigate cases where the IMF By component is positive and negative. We investigate the excitation mechanism of the pulsation, determining its qualitative polarization characteristics. A complex demodulation technique is employed to determine the amplitude and phase relationship between field components observed by the radars and other data sets, which gives wave number and phase velocity characteristics of pulsations. We investigate magnetic pulsations in the context of MHD theory, grouping them under various source mechanisms to obtain their statistical occurrence.

Poster Session 2 / 256

Magnetic and thermodynamic properties of the CeIrGa4 compound.

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A polycrystalline sample of CeIrGa4 was prepared by an arc-melting technique using high-purity elemental constituent elements on a water-cooled copper plate under ultra-high pure argon atmosphere. This compound crystallizes in an orthorhombic structure having the CeOsGa4 structure type belonging to the space group Pmma [1]. The sample was characterized by powder X-ray diffraction spectra which were refined using EXPO software, where the lattice parameters were found to be; a = 9.456(3) Å, b = 8.726 (2) Å and c = 7.547 (3) Å. In this work, we study the physical and magnetic properties of this compound, by heat capacity Cp(T), magnetization M(B), magnetic susceptibility χ(T) and electrical resistivity ρ(T). In the χ(T) results a Curie-Weiss behaviour is followed above 50 K, yielding an effective magnetic moment, ueff = 2.43 (2) uB/mol-Ce, which is close to the theoretical value for a free Ce3+ ion. This indicates that Ce3+ is the only magnetic species in this compound. The paramagnetic Weiss temperature is up = – 97.42 (2) K. The negative value of the Weiss temperature indicates that AFM interactions dominate. The magnetization shows typical paramagnetic behaviour above 15 K, where M is linear in B up to 8 T. However, in the T = 2 K isotherm a strong curvilinear behaviour is observed with a weak tendency towards saturation and a steep rise in M at very small fields. This suggests a possible phase transition at very low T in this compound, even though our maximum field extracts only about 0.5 μB/Ce. The electrical resistivity follows a ρ(T) ~ - log(T) behaviour below room temperature which is in evidence of incoherent Kondo scattering effects in this compound. A coherence or Kondo-lattice peak in ρ(T) develops at 90 K, below which ρ decreases sharply. Above 2 K, ρ(T) shows an anomalous near – linear rise with temperature. The electronic specific heat, Cp(T)/ T increases sharply below 10 K to reach a very high value of 600 mJ/mol.K2 at 2 K. Our interpretation of the physics in CeIrGa4 is that this is a new example of a strongly correlated, Kondo- lattice system. Future studies will focus upon the low temperature region to search for a possible magnetic phase transition.

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Poster Session 1 / 257

The Socio economic analysis of the Ethiopian Government investing in the green economy through Biomass 2005-2016

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The climatically conditions in Ethiopia are difficult, with a great gradation of sometime in between the year and three-dimensional unevenness in high temperature and precipitation. The ambiguity about meteorological conditions is growing with environment alteration (UK Government, 2016: 1). The country has an extended past of far-reaching food crisis prompted or aggravated by a life-threatening famine, particularly in 1973 to 1974 also1984 to1985 (UK Government, 2016: 1).

In the past few years the Government of Ethiopia has embraced various ground-breaking and operative techniques to raise domestic, communal and nationwide pliability to weather tremors and strain; and to pledge to a “green, low carbon” growth way, taking advantage of Ethiopia’s important “renewable energy” assets to provide energy power for industrial development and urban migration (UK Government, 2016: 1).

The mainstream of the forty five thousand “public works projects” accomplished annually over “PSNP public works” workers concentrate on land and aquatic preservation, by means of walkways, planting of trees and channel regulator methods to capture and inverse the special effects of fast overspill and soil corrosion on desolated and over browsed land and hills (UK Government, 2016: 1). The reintegration and safeguarding of watersheds using public works is likely to effect in substantial CO2 seizure and confiscation in lands and biomass in fenced zones (UK Government, 2016: 3).

Ethiopia is amongst the fastest growing non-oil economies in the world (Trading Economics, 2016: 1). “Expansion of services and agricultural sectors explain for greatest of this growth, while manufacturing sector performance was somewhat unassertive”. “Private consumption and public investment enlighten demand side growth with the later supposing a gradually significant part in recent years” (World Bank, 2016: 1). While 38.7% of Ethiopians lived in extreme poverty in 2004-2005, five years later this was 29.6%, which is a decrease of 9.1% as measured by the national poverty line, of less than $0.6 a day (World Bank, 2016: 1). The investment in Biomass and other projects are influencing climate change for the positive.

Applied Physics / 258

Nickel substituted Spinel-type zinc ferrite nanostructures prepared by microwave-assisted hydrothermal and their structural, luminiscence and gas sensing properties.

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Various volatile organic compound (VOCs) gases are released from a wide range of products commonly found in buildings resulting in indoor environmental pollution thus posing risks to human health. Much attention has been dedicated on development of spinel-type ferrites as gas sensors for detection of VOCs gases and environmental monitoring. However, the growing demand of highly responsive, selective and stable sensors still persists with the ever growing industrialization. In this work, NixZn1-xFe2O4 (x = 0, 0.1, 0.3, 0.4) nanostructures were facilely prepared using microwave-assisted hydrothermal technique followed by annealing at 500 °C. The effect of Ni substitution on the structural and optical properties as well as specific surface area was investigated through various characterization techniques including scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray diffraction (XRD), Brunauer–Emmett–Teller method, and Photoluminescence (PL) spectroscopy. Gas sensing performances of the ZnFe2O4 nanostructures were investigated for Acetone (C3H6O), Ethanol (C2H6O) methane (CH4), carbon monoxide (CO), ammonia (NH3) and hydrogen (H2) gases at an optimized operating temperature of 120 °C.

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Electrical and mechanical degradation analysis of degraded single junction amorphous silicon solar modules

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The electrical and mechanical degradation analysis of degraded single junction amorphous silicon solar modules have been studied. This study was motivated by his quest to understand the fundamental principles behind the degradation and the low stability that is usually experienced by amorphous silicon solar (a-Si:H) modules. The electrical performance parameters of a-Si:H modules were investigated under both outdoor and indoor conditions. The study also involved the characterisation of defects and mechanical degradation analysis of the a-Si:H modules. Indoor characterisation was used to investigate the effect of degradation on the intrinsic properties of the a-Si:H modules using Kelvin Probe Microscope at nano-scale level to measure the surface contact potential. The study established that the degradation of the mechanical properties of a-Si:H modules is a major contributor to the electrical degradation of the modules as oppose to the other way around. The study recommends an improvement on the adhesive force between different layers of a-Si:H modules in order to reduce the degradation and improve the stability of these modules.

Poster Session 1 / 260

Internal conversion coefficients from conversion electron sources

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Internal Conversion (IC) is an important component of most nuclear decay schemes, in order to balance a decay scheme correctly, one need to know IC contribution to each transition [1]. The knowledge of the IC processes is of importance for the evaluation of absolute and relative radiation strengths. Furthermore the study of correlations involving IC offered the possibility to determine the parity change in a transition [2].
Over the last decade, tabulated internal conversion coefficients (ICC) values have differed significantly from one calculation to another by a few percent. Such differences cannot be tolerated in some applications. The best agreement data was achieved with a version of Dirac-Fock method calculation that ignored the atomic vacancy created by the conversion process [3]. The problem of whether or not to take into account the hole in the atomic shell after conversion has been considered in a number of papers both with respect to the validity of the ICC theory and to the quality of agreement between that theory and experimental data [4, 5].
In this work experimental ICC for nuclei across Z≈50 are determined in two different methods and compered to the two theoretical methods.

Physics Education / 261

Ideas around using Google Earth as a pedagogic tool for teaching wave concepts in the era of Industry 4.0

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The advent of the Fourth Industrial Revolution requires physics teachers and lecturers to re-look at the way physics concepts are traditionally taught in order to accommodate a more interactive and technology-focused teaching approach. In most textbooks wave concepts are presented with the aid of diagrams that are usually drawn in a very abstract way, i.e. as a mathematical function on a (x,y) two-dimensional Cartesian plane or by means of an oscillating string. This makes it difficult for students to visualize wave concepts in three-dimensions and to link them to phenomena occurring in real life. Technology offers us opportunities to explore different avenues for teaching wave physics. Google Earth provides copious examples of water wave phenomena at the surface of rivers, lakes and oceans, that can be used effectively to describe general wave concepts such as refraction, reflection, diffraction, interference and Huygens' principle. We present ideas on how to implement Google Earth images in the curriculum of the second year undergraduate course on Waves and Optics presented to science majors at the University of Johannesburg. The aim is to teach students to also use intrinsic quantitative tools in Google Earth to verify fundamental wave laws and equations. The above will be implemented in the course as from the 2020 academic year.

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Reconfigurable infrared hyperbolic metasurfaces using phase change materials

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Metasurfaces control light propagation at the nanoscale for applications in both free-space and surface-confined geometries. However, dynamically changing the properties of metasurfaces can be a major challenge. Here we demonstrate a reconfigurable hyperbolic metasurface comprised of a heterostructure of isotopically enriched hexagonal boron nitride (hBN) in direct contact with the phase-change material (PCM) single-crystal vanadium dioxide (VO2). Metallic and dielectric domains in VO2 provide spatially localized changes in the local dielectric environment, enabling launching, reflection, and transmission of hyperbolic phonon polaritons (HPhPs) at the PCM domain boundaries, and tuning the wavelength of HPhPs propagating in hBN over these domains by a factor of 1.6. We show that this system supports in-plane HPhP refraction, thus providing a prototype for a class of planar refractive optics. This approach offers reconfigurable control of in-plane HPhP propagation and exemplifies a generalizable framework based on combining hyperbolic media and PCMs to design optical functionality.

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DELINEATION OF GROUNDWATER CONTAMINATION USING ELECTRICAL METHOD AT DUMP SITE IN AWKA URBAN LOCALITY, ANAMBRA STATE, NIGERIA.

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A resistivity survey was carried out to study the level of groundwater pollution in the dumpsite at Awka Urban Anambra State. Depth, thickness, resistivity, and sediment at which contamination of groundwater occurred were also established. From the analysis, the dump site has four layers, contaminated topsoil, subsoil, rock fragment, and bedrock while the control side has four layers also which are, topsoil, subsoil, rock fragment, and bedrock. The effect of leachates can be seen at the dump site, the first layer (contaminated topsoil) with low resistivity values and this effect tend to affect some distance at the second layer (subsoil). The control site has no effect of leachate which shows high resistivity values at its first and second layer compare to that of the dump site. The iso-resistivity maps also reveal the variation between the dump site and control site, at the 5 m and 10 m plot of the iso-resistivity maps, the dump site (profile A to D), shows low resistivity values compare to the control site (profile E and F). At the 12 m depth, the resistivity values at the dump site and control site tend to be at a similar range, which explains that the effect of leachate disappears at 12 m depth. At 20 m depth, the resistivity values at the control site (Western side of the map) is lower than that of the dump site which could explain the effect of water-bearing materials or weathering of the rocks at that depth.

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Independence of Inductive kick on Inductance of a Pulse Induction Circuit

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It is commonly believed that inductive kick or back electromotive force (EMF) generated by a coil depends on the magnitude of its inductance. This, intuitively, is in line with Faraday's law of electromagnetic induction. This work seeks to show that this is not necessarily the case. Starting from basic principles, this work presents a theoretical analysis which shows that the back EMF generated by a pulse induction coil does not depend on inductance. Rather, the back EMF is a function of the ratio of the load to the coil resistance. The theoretical analysis is supported with results of circuit simulation and a real-life example confirming the independence of the back EMF on inductance.

Poster Session 2 / 267

Electrical characterization of n-type silicon diodes semiconductor material doped with tungsten particles.

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n-type Silicon has been doped with tungsten particles at ion energies ranging from 50keV to 150keV, silicon was then characterised using Rutherford backscattering spectroscopy and depth profiling for the analysis of the doped material. Schottky barrier diodes were fabricated on the silicon doped with tungsten particles and those that are not doped, AuSb was used as an ohmic while Pd was used as a schottky contact. Current-voltage (I-V) and capacitance-voltage (C-V) measurements were carried out at room temperature (300K). The parameters studied from I-V measurements were saturation current (Is), ideality factor (η) and schottky barrier height (ΦIV). For the C-V measurements The results show that the diode fabricated show typical diode behavior of silicon diodes and the barrier height is shown to have decreased with the increase in ion energy.

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Analytical modelling of thermal properties of possible fuel materials for aluminum smelting

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Many different fueling materials are used in the smelting of aluminum as used by rural foundry men in rural communities in South Africa. One lists namely coal, firewood, cow dung, and macadamia nutshells. While emission and heat radiation generated due to a poor heat containment leading to a possible biodiversity degradation environment pollution and contribution to climate change, a systematic study on environmental monitoring nor technical attributes of used or usable fuel materials is not reported. This paper uses algebraic linear combination of paired possible fuel materials to demonstrate their contribution to the generated heat. Possible emission would be studied and their contributions justified in terms weighted average of each component.

Poster Session 1 / 270

Optimization of convective heat transfer coefficients during “garification” process using Artificial Neural Network (ANN) Modeling

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The garification process is a food preparation method which depends on process factors such as cassava age, fermentation days and temperatures. These process parameters affect the yield and quality of the gari especially during roasting (garification). This paper report on findings from a study where the convective heat transfer coefficients during garification process were examined. The material losses and yield of gari sample obtained, at different processing stages, from cassava roots of different ages, on fermentation days and at varied garification temperatures and time were evaluated. The effects of cassava processing variables [cassava ages (9, 12 and 15 months), fermentation days (0 - 6 days), garification temperatures (100, 120 and 140oC and time, (t) (0 – 21minutes)] on the thermo-physical properties of the product were determined using standard laboratory methods. The temperature changes of garification process were monitored, under natural and forced convection. The dimensionless numbers associated with convective heat transfer coefficients were estimated. Artificial Neural Networks (ANN) model was employed in this study. The feed forward network structure with input, hidden layer(s) and back propagation network algorithm was utilized in model training. A log sigmoid transfer function was used for input layers while pure-line transfer function was used for output layers for the modeling of the processes. Results showed that mean garification conversion rate achieved was 0.22(wt/wt). Cassava roots of 15 months age of maturity produced higher yields of gari. The dimensionless numbers obtained for garification process predicted optimally (R2>0.9) the relationship between momentum and heat transfer by diffusion. These were used to determine the magnitude of convective and evaporative effects at the surface. The estimated values of convective heat coefficients for the garification process ranged from 4.92 to 38.62 W/m2 oC. Empirical equations developed for heat transfer coefficients [$hc=0.017t^2-0.388t+3.039$] with (R2>0.9) were best described by polynomial relationships and the effectiveness of these results were validated using the ANN model, with mean error of less than 10%. The optimum ANN model produces convective heat transfer coefficients with two hidden layers and twenty five neurons in each hidden layer, with mean square error, mean absolute error and sum square error of 0.000016, 0.0029 and 0.0085%, respectively, with R2 of 0.992. The study showed that optimization of the combined effects of the cassava processing variables gave higher yield and good quality gari, which was achieved using 15 months cassava, fermented for three days with garification temperature and time of 120oC and 15 minutes, respectively.

Applied Physics / 271

Optical sensitivity of CdS-Au nanocomposites prepared by physical techniques: pulsed laser deposition and sputter coating.

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In this work we seek to understand the role played by the shape and size of co-catalyst nanoclusters on the semiconductor surface optical properties. The preparation of nanocomposites is of high importance in science and engineering. These are usually prepared with chemical methods and in this work we also try to counter the role played by solvents in the preparation of these structures. This is done by using two physical techniques: pulsed laser deposition (PLD), which is famous for not altering the stoichiometry of materials and sputter coating (SPC). The optical sensitivity of semiconductor material is enhanced by combining them with metal components.
The new material performs much better than the individual components. The presence of the nanoclusters on the CdS surface attests itself by the enhancement in the absorption intensity of the NCs. The ultraviolet-visible (UV-Vis) spectrum of the SPC nanoclusters showed the highest increase, just as photoluminescence (PL) quenching was observed to be the highest for these agglomerated nanoclusters. This shows the creation of a Schottky junction which allows for the transfer of more electrons from the semiconductor conduction band to the metal valence band of the SPC NCs.

Theoretical and Computational Physics / 272

Molecular Finite Element Density Functional Calculations employing a Cusp Factor

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Finite element calculations have been performed in Cartesian coordinates using the density functional approach
for a number of small molecules. In order to aid convergence
of the orbitals and total energies a suitable cusp factor was employed, such that the resulting effective potential is non-singular at all nuclei. The resulting total energies
and densities were compared with those obtained using the Gaussian basis set package NWChem and excellent agreement was found.

Theoretical and Computational Physics / 273

Solving differential equations of Quantum Mechanics in 1 D and 2 D using Sinc functions employing Python and Numpy.

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The Schroedinger equation in one and two dimensions is solved using sinc functions, applying the variational principle and employing Python and Numpy. Our goal is to examine how the sinc function method performs with respect to its convergence rate. The python codes are tested with the quantum harmonic oscillator potential and Morse potential, for which analytical solutions are available.
It is found that the method converges quickly.

Poster Session 2 / 274

Structural and magnetic characterization of Sm3+ ion substituted Zn-Mn nanoferrites synthesized by glycol-thermal method

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Zn0.5Mn0.5SmxFe2-xO4 ($0 \le x \le 0.05$) fine powders with average crystallite size in the range 12-17 nm were synthesized by glycol-thermal reaction. The as synthesized compounds were subjected to the annealing process of 1100 DC, after which the crystallite size increased to about 60 nm. XRD analysis confirmed a single phase cubic spinel structure in all the compounds investigated. TEM images showed nearly spherical particles with uniform particle size distributions. The Mössbauer spectrum of Zn0.5Mn0.5Fe2O4 (x = 0) oxide could be resolved into two quadrupole doublets indicative of paramagnetic spin state. Sm3+ substituted Zn0.5Mn0.5SmxFe2-xO4 ($0.01 \le x \le 0.05$) fine powders show weak sextets in addition to broad doublets attributed to some particles magnetic moments in ordered magnetic phase. The Mössbauer spectra of the compounds annealed at 1100 DC exhibit magnetic split sextets indicative of ordered magnetic phase. The compounds have small coercive fields and high saturation magnetization (40 emu/g to 60 emu/g) which reduces with increasing Sm3+ content due to the paramagnetic nature of Sm3+ ions.

Applied Physics / 275

Predicting scuffing by modeling bottle movement on a multi-track conveyor.

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The South African beer industry encourage customers to return empty 750ml beer bottles to retailers and receive a refund for recycled bottles. These bottles are then re-used, but after multiple cycles the bottles eventually exhibit visual signs of scuffing – an opaque ring at the base and sometimes shoulder of the bottle. Scuffing is correlated to bottle explosions during the refilling process. A simulation model is developed to examine the number of collisions and contact duration of bottles on a conveyor system. The model includes bottle-to-bottle, and bottle-to-barrier collisions. An initial bottle trajectory visualization tool developed with Wolfram Mathematica® software will be presented.

Space Science / 276

On the Effects of Dissipation Range Turbulence on the Perpendicular Diffusion Coefficients of Cosmic Ray Electrons

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The perpendicular diffusion coefficient (DC) plays a crucial role in the transport of low-energy cosmic ray electrons, which include a proportion of solar energetic particles, electrons originating in the Jovian magnetosphere, and electrons of galactic origin. In turn, various properties of heliospheric magnetic field turbulence have a strong influence on perpendicular DC expressions derived from theory. Deriving such expressions for realistic forms for turbulence power spectra is, however, difficult, as this involves dealing with relatively intractable integrals. This study presents such expressions, derived from the random ballistic decorrelation interpretation of nonlinear guiding center theory and assuming a 2D turbulence power spectrum that includes a dissipation range. These novel results will be compared with previously published perpendicular DCs derived from this theory which do not include the effects of turbulent dissipation, and will be used to ascertain the potential effects of dissipation range quantities on the perpendicular transport of low-energy electrons in the heliosphere.

Applied Physics / 277

Response surface methodology optimization of adsorption and kinetics of Ca removal from aqueous solution using macadamia nutshell biochar

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Response surface methodology optimization of adsorption and kinetics of Ca removal from aqueous solution using macadamia nutshell biochar

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Macadamia nutshells collected from Nelspruit (Mpumalanga) were pyrolyzed using a tube furnace and microwave heating process. The produced biochar was activated chemically with varying concentrations of HCL, H2SO4, H3PO4 and HNO3 to improve their adsorption ability. The optimised removal of calcium from a gold elution effluent is the focus of the project. This paper reports on the use of response surface methodology to optimise the adsorption isotherm of the calcium removal from aqueous solutions generated to mimic the plant effluent. The kinetics study complements the paper. BET, SEM, TGA FTIR, XRF and XRD were utilised to characterise both the as-received nutshells, the produced biochar and the Ca-loaded activated biochar. The behaviour in an attrition test as well as their proximate analysis data will be discussed in the light of the optimised Ca removal. The collected Ca adsorption parameters will be validated using the response surface methodology.

Keywords: Isotherms of adsorption, biochar, macadamia nutshells, kinetics study

Physics of Condensed Matter and Materials / 278

Unraveling the combined influence of Oxygen vacancies and functional pillared effect on scalable Ni-Co LDH based high performance supercapacitor electrode materials properties

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The increasing environmental challenges such as the rise of global warming and the depletion of fossil fuels triggered the in studying various clean energy technologies. Such, including fuel cells, solar, wind, geothermal and tidal power. The energy produced by these systems requires an energy storage device, for the energy to be used over a long period. Modern energy storage devices include supercapacitors Lithium-ion batteries and molten salt, just to mention a few. Amongst them, the supercapacitors have the highest energy density, long lifespan and allow safe operation.

In the present study, we have developed electrode material for supercapacitors by combining both the pillar effect and oxygen vacancies via strategic annealing temperature of scalable NiCo-LDH resulting to the enhancement of supercapacitors performance.

the as-obtained NiCo-LDH was successfully synthesized, having the diffraction peaks centered at 12.28°, 24.67°, 33°, 36.41° and 59°. The peaks were assigned relative to the standard card (JCPDS no. 14-0191), and corresponded to (003), (006), (009), (012) and (110) plane of hydrotalcite- like LDH.

Theoretical and Computational Physics / 279

Simulations in large N gauge theories with finite chemical potential

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Using complex Langevin dynamics and stochastic quantization we examine the phase structure of a large N unitary matrix model at low temperature with finite quark chemical potential. This model is obtained as the low temperature effective theory of QCD with N number of colors and N_f number of quark flavors. We simulate several observables of the model, including Polyakov lines and quark number density, for large N and N f . The action is manifestly complex and thus the dominant contributions to the path integral come from the space of complexified gauge field configurations. For this reason, the Polyakov line eigenvalues lie off the unit circle and out in the complex plane. A distinct feature of this model, the occurrence of a series of Gross-Witten-Wadia transitions, as a function of the quark chemical potential, is reproduced using complex Langevin simulations.

Poster Session 1 / 280

Design of a national indoor radon survey for South African Homes: review of existing indoor radon concentration data and associated measurement techniques

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Radon 222Rn is a natural radioactive gas directly produced from the decay of Radium, 226Ra found in rocks and soil. Since radon is a gas, it can move freely through the soil allowing it to escape into the atmosphere or flow into buildings. South Africa is facing the challenge in mine dumps which contribute radon exposure to the public. The World Health Organization (WHO) and the International Atomic Energy Agency (IAEA) studies have shown that elevated radon-in-air levels are associated with an increased risk of developing lung cancer. Over the years surveys of indoor radon levels were performed in Asia, Europe, America, and Canada which include several countries. In 2018 the Centre for Nuclear Safety and Security (CNSS) in South Africa, initiated a project call to design a national indoor radon survey in South Africa. Stellenbosch University was successful in getting funding to execute this project. Here we report on results from our desktop-based survey of existing indoor radon levels for South Africa. We present an initial statistical analysis of the data and use the data to investigate the notion that the radon level in homes follows a lognormal distribution. We also present a summary of radon measurement techniques used to date.

Theoretical and Computational Physics / 281

Finite element modelling of thermal stress on lining of a crucible furnace

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The objectives of the research reported herein was to determine the composite wall of a crucible furnace for a contained heat and reduced heat loss to the ambient using Finite Element Method (FEM) considering transient heat conduction. This paper presents findings on heat transfer characteristics of a crucible furnace wall designed and constructed for the smelting of aluminium scraps in artisanal casting of three legged aluminium pots. The approach would be extended to a static kiln cylindrical hollow furnace for clinkers production from carbonates locally found in remote rural areas. Thermal stresses experienced by the lining (concrete and ceramic refractory materials) of crucible furnace was modelled and simulated using finite-element method. The findings permitted to perform the structural analysis for the determination of thermal stress in different working condition and ascertain the appropriate lining materials for the used heating material (coal, firewood, cow dung, macadamia nut shells, or a combination of the above).

Poster Session 1 / 282

Probabilistic forecasting of solar irradiance: An application to South African data

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Probabilistic forecasting of medium-term global solar irradiance (GSI) using data from Tellerie radiometric station in South Africa for the period August 2009to April 2010 is discussed in this paper. Variables are selected using a least absolute shrinkage and selection operator (Lasso) via hierarchical interactions and the parameters of the developed models are estimated using the Barrodale and Roberts's algorithm. To improve the accuracy of forecasts, a convex forecast combination algorithm where the average loss suffered by the models is based on the pinball loss function is used. A second forecast combination method which is quantile regression averaging (QRA) is also used. The best set of forecasts is selected based on the prediction interval coverage probability (PICP), prediction interval normalised average width (PINAW) and prediction interval normalised average deviation (PINAD). The results demonstrate that QRA is the best model since it produces robust prediction intervals than other models. The percentage improvement is calculated and the results demonstrate that QRA model over GAM with interactions yield a small improvement whereas QRA over a convex forecast combination model yields a higher percentage improvement. A major contribution of this study is the inclusion of a non-linear trend variable and the extension of forecast combination models to the QRA.

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STABILITY OF EXCITONIC STATES IN AN EXTRINSEC SEMICONDUCTOR USING FEYNMAN PATH INTEGRALS

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We investigate the stability of excitonic states, which are pairs of fermionic particles, by using Feynman Path Integrals methods and Grassman algebra that best describes fermions. The system is decoupled using Berezin integral. Working in the reciprocal space allow us to write the total action functional express in terms of interacting and non-interacting Green functions. This action functional also reveals the fluctuations arriving during the displacement of the exciton in semiconductor. The Bethe Salpeter equation applied help to establish the parametrs like polarization, total energy and density of states. The binding energy is found to be large compare to the electron-hole unbound energy ending to the stability of the particle. The obtained parameters strongly depends on the impurity alowing one to predict about the future of the particle in presence of fluctuations. All these results are confirmed by the diagrams sketched and that could be a predictive experimental study on the excitonic states. It is demonstrated that the Feynman diagrams obtained are in accordance with the analytical results and reveal the fact that the system contains more fluctuations that can predict its stability. This work is a good understanding in donors impurities for transport applications of a doped semiconductor.

Space Science / 284

Solar Observation, Space Weather and the Computation of Sunspot Dynamics

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Solar phenomena such as solar prominences, -flares and -coronal mass ejections (collectively known as solar variations) directly influence our way of life on Earth by impacting its atmosphere, climate and magnetic field. Furthermore the success of all scientific endeavours within the solar system and the prospects of space travel are significantly impacted by space weather. It is therefore crucial to understand the root of solar variations to safeguard our way of life on Earth and to circumvent the obstacles space weather poses to our aspirations. Solar variations can directly be linked to regions of intense magnetic activity on the sun's surface – known as sunspots. Our understanding of solar variations can be improved by the observation and computation of the short- and long-term dynamics of these sunspots. Our methodology and efforts regarding solar observation, which includes the initial set-up of a solar telescope, and the computation of sunspot dynamics will be showcased and its context with relation to space weather will be presented.

Poster Session 2 / 285

Effect of temperature and concentration on hematite nanostructures prepared by chemical spray pyrolysis

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Hematite films were deposited by chemical spray pyrolysis on fluorine doped tin oxide at elevated temperatures (250 - 400°C). 0.05 M, 0.10 M and 0.15 M of iron(lll)chloride hexahydrate (FeCl3.6H2O) was used as precursors for hematite with nitrogen (N2) as the carrier gas. Scanning electron microscopy of the hematite films showed small grain sizes of < 100 nm, with a uniform distribution on the film. Raman spectroscopy revealed two A1g and five Eg symmetrical vibrational phonon modes of hematite. X-ray diffraction results confirmed (104) and (110) which are dominant diffraction peaks associated with a corundum hexagonal hematite structure. The films exhibited an indirect band gap varying from 2.31–1.97 eV. The as-prepared hematite films have a potential application in photoelectrochemical water splitting to produce hydrogen gas.
Key-words: Spray pyrolysis, hematite, nanostructures.

Space Science / 286

Turbulence conditions at the beginning of the space age: a preliminary analysis

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Solar cycle 20, in the mid 1960s, was very unusual in that the usual cosmic ray intensity decline towards solar maximum was not accompanied by an increase in heliospheric magnetic field magnitude as seen in subsequent solar cycles. This presents something of a quandary where cosmic ray modulation studies are concerned. This study presents a novel investigation of historic magnetic field spacecraft observations from this period, in an attempt to increase our understanding of modulation conditions, particularly those concerning the diffusion of cosmic rays, during this time. The available magnetic field data in this period have not been previously subjected to modern turbulence analyses, probably due to the high percentage of omissions and low cadence of data. This study presents the preliminary results of an analysis designed to take these challenges into account in order to study turbulence conditions in this time, and to compare these conditions to those present in subsequent solar minima.

Poster Session 2 / 287

Structural and optical properties of hematite films prepared by spin coating at varying ramping rates

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In this study, we investigated the impact of ramping rate on the structural and optical properties of hematite films prepared by spin coating. Four samples of hematite films were deposited on FTO substrate at 500°C sintering temperature and 1, 4, 8 and 12°C ramping rates respectively. XRD studies of the films revealed prominent peaks for hematite at (104) and (110) with weak reflections at (012), (113), (024), (122) and (310) planes. FE-SEM revealed spherical nanoparticles with some agglomeration into larva-shaped nanostructures. Films prepared at ramping rate of 4°C and higher showed cracks on their surfaces which increases with ramping rate. In addition, using Raman spectroscopy, increasing the ramping rate resulted in increasing red shifting of the optical phonon modes of hematite. Similar pattern of red shifting of UV-Vis absorption spectra was observed with increasing ramping rates. This was attributed to physical defects in the films which appeared in form of cracks as a result of increasing ramping rate. The films could be used as photoanodes in a PEC cell for water splitting and the level of physical defects in the films may impact on their performance.

Poster Session 2 / 288

Study of structural damage in InGaN thin films due to Cu ion irradiation

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The influence of erbium (Er+) ion irradiation on the structural modification in indium gallium nitride (InGaN) thin films is studied by a combination of Rutherford backscattering spectrometry and channeling (RBS/C) and Raman spectroscopy. Epitaxial InGaN thin films, with thicknesses of 20 nm, grown on sapphire substrates with gallium nitride (GaN) buffer layers, were irradiated with 170 keV Er+ ions at fluences of 1 x 1014, 5 x 1014 and 1 x 1015 ions/cm2 at room temperature. Structural properties of the films were investigated to understand the effects of ion fluence on the irradiated thin films. RBS/C results show that the calculated channelling minimum yield (Xmin) of the films decreases with increasing ion fluence, indicating that the crystalline quality of the InGaN thin films has improved. However, at high fluences RBS results exhibit sputtering of the InGaN layer. Results of this study confirms that the previously observed re-crystallization in InGaN films after ion beam irradiation [1] does not seem to depend on ion beam type or energy and this may have beneficial implications for control of irradiation-induced improvement in InGaN thin films.

[1] Madhuku, M., Husnain, G., Ahmad, I., Saleem, H (2015): Irradiation-induced improvement in crystalline quality of epitaxially grown InGaN thin films: A preliminary study. In: Proceedings of SAIP2014, the 59th Annual Conference of the South African Institute of Physics, edited by Chris Engelbrecht and Steven Karataglidis (University of Johannesburg), 059-065.

Poster Session 2 / 289

Stability of Methylammonium Lead Tri-bromide with Diffused Metal Electrodes

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The interactions between aluminium, gold, silver, tin, gold/zinc metal electrodes with methylammonium lead tribromide perovskite were studied. The metals were deposited on the substrates by physical vapour deposition using a resistive evaporator. Likewise, methylammonium lead tri-bromide perovskite thin films were grown on the deposited metal films by sequential physical vapour deposition of lead (II) bromide and methylammonium bromide. The structural and morphological properties were observed over a period of one month. Field emission scanning electron microscopy showed that aluminium reacts aggressively with the perovskites immediately after deposition leading to exfoliation of the grains. X-ray diffraction patterns confirmed that the exfoliation was a result formation of alumina in air. On the other hand, gold/zinc alloy was relatively stable with methylammonium lead tri-bromide. This study paves the way for the selection of electrode metals for stable methylammonium lead tri-bromide perovskites solar cells

Poster Session 2 / 290

Cryogenic ion implantation of Polyethylene Terephthalate thin films: structural and electrical properties

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Polymer based nanocomposites have attracted a lot of attention in the semiconductor industry for many different applications such as sensors, solar cells, lighting and display, to name a few. Polyethylene Terephthalate (PET), an insulating polymer with electrical conductivity of up to 10-15 S.m-1 shows desirable electrical characteristics after ion implantation. In this work, 100keV Ti+ and Ar+ ions were cryogenically implanted into Polyethylene Terephthalate (PET) foils of about 130 µm thickness. The PET samples were then characterized using Fourier-Transform Infrared (FTIR) Spectroscopy to determine the chemical and molecular structure of implanted species. UV-Vis was carried out to determine the electronic band gap and XRD to determine the crystallinity. The electrical properties of the implanted PET were investigated through current-voltage (I-V) measurements. This presentation describes and explains results of the characterisation measurements with a view to establishing structure-property relationships of the cryogenically implanted PET. The ultimate goal of this study is develop polymer based nanocomposites for applications in nuclear and solar radiation sensor devices.

Composition induced structural evaluation in BO3-3, PO4-3 and SO4-2 substituted CaMoO4:Dy3+ phosphors for application in White-Light LEDs

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A series of novel white light emitting CaMoO4:Dy3+ (1.0 mol %) phosphors substituted with different anionic groups (BO3-3, PO4-3 and SO4-2) were prepared using a high temperature solid state reaction method. The effects of anionic substitution on the crystalline structure and photoluminescence (PL) properties of the CaMoO4:Dy3+, CaMoO4-BO3:Dy3+, CaMoO4-PO4:Dy3+and CaMoO4-SO4:Dy3+ phosphors were investigated. The X-ray diffraction (XRD) patterns confirmed that the phosphors to be crystallized in a pure scheelite-type tetragonal structure. The field emission scanning electron microscopy (FE-SEM) images showed that the particles were agglomerated together and they had no definite size. The chemical composition analyses and the electronic states were analyzed using the energy-dispersive X-ray spectroscopy (EDS) and X-ray photoelectron spectroscopy (XPS) respectively. The Fourier transform infrared spectroscopy (FTIR) data supplemented both the XRD and EDS data by confirming that the stretching mode frequencies were all related to BO3-3, PO4-3 and SO4-2 except a few absorption peaks ascribed to atmospheric moisture and hydrocarbons. The band gaps measured from the ultraviolet visible spectroscopy (UV-Vis) data were shown to vary for the different anionic group systems. The excitation spectra of the phosphors were characterized by broadband extending from 250 to 500 nm. Upon near-UV excitation, the phosphor emits intense blue and yellow light with a weak red bands, which originated from 4F9/2⟶6H15/2, 6H13/2, 6H11/2 transitions of Dy3+ ion respectively. Furthermore, high intensity white light color emission was achieved by substitution of different anionic groups (BO3-3, PO4-3 and SO4-2) into the CaMoO4:Dy3+ phosphors. Among all the studied phosphors, the CaMoO4-SO4:Dy3+ phosphor showed the strongest PL emission compared to all other phosphors suggesting that it is a promising potential candidate for red emission in the near UV excited white LED applications.

Structural and Dynamical Properties of Pentlandite Nanostructures: Atomistic Simulation Approach.

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Atomistic simulations were carried out to study the melting behaviour of pentlandite nanostructures, in order to understand their structural and dynamical properties. Pentlandite is a major precious metals-bearing mineral and plays a very important role in mining. Precious metal ores co-exists with base metals either as solid-solution and intergrowths, hence rendering its detailed understanding important for efficient extraction of these precious metals. This work relates to problems in applied areas such as mineralogy, geophysics and geochemistry, whereby phase transition is modified by impurities, so there is the additional concern of the effect of temperature. Computational modelling technique, molecular dynamics (MD) was performed to provide atomic or molecular level insights of the structural and dynamics of pentlandite nanostructures. The effect of temperature on different sizes of nanostructures was determined via the structural and dynamical properties; namely radial distribution functions (RDFs), variation of energy as a function of temperature and diffusion coefficients. Both mechanisms reveal that as a size of nanostructure increases, the melting temperature increases.

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Improving energy density in symmetric supercapacitors from optimized activated carbon using non-aqueous electrolytes

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Improving energy density in symmetric supercapacitors from optimized activated carbon using non-aqueous electrolytes

The formation mechanism of the porous framework in nanostructured carbon materials is important in a wide variety of applications such as in supercapacitors, gas storage, adsorbents and catalyst supports. The accessibility to the pore sites by electrolyte ions and gases are highly determined by the precise synthesis techniques adopted for these materials. As such, biomass waste materials are a good choice for synthesis as they are available in abundance and cheap, while containing high carbon content and giving high specific surface area for electrochemical supercapacitor applications.
In this study, activated carbon (AC) was synthesized from renewable plant biomass waste using a chemical vapour deposition (CVD) technique via a pre-hydrothermal conversion step and compactivation along with the fine-tuning of key growth parameters, including activation time.
The textural, structural and morphological features were investigated by the Brunauer-Emmett-Teller (BET) technique, X-ray diffraction (XRD), Scanning/Transmission electron microscopy (SEM/TEM) and Energy Dispersive X-ray Spectroscopy (EDS) characterization. The material tested in a three-electrode configuration exhibited electric double-layer capacitor (EDLC) behaviour and working comfortably in KNO3 aqueous electrolyte in both negative and positive operating widow of 0.80 V. The material also exhibited higher gravimetric energy of over 55 Wh.kg-1 and gravimetric power of 700W.kg-1 at 0.5 A.g-1 gravimetric current in ionic liquid electrolyte. The results from this study provide the pathway into designing hierarchically porous materials from cheap and sustainable sources suitable in high power energy storage devices. The improvement of the energy densities are also achieved using of ionic liquid electrolytes.

Physics Education / 294

Death of an Outcome Revisited.

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Previous studies in which physics examinations at matriculation and first-year level have been analysed, have described evidence of a favoured question-type that can be taught explicitly and relatively easily mastered. This favoured question-type typically makes up such a disproportionately large fraction of the marks for an examination that candidates can pass the examination without having to demonstrate any real problem-solving ability. This has been offered as a tentative and partial explanation for a perceived weakness in students' problem-solving ability. What has not been reported on previously, is the question of candidate performance relative to question-type, which has in the past been difficult because of lack of access to the relevant data. In the last few years the Department of Basic Education has been publishing "Diagnostic Reports" of the South African matriculation results each year which have been featuring the average marks earned per sub-section by the candidates. This makes it possible now to analyse an examination and classify the questions (according to the typology developed in our earlier studies) and then compare the patterns emerging with the average performance of the examination candidates. The results of this analysis will be presented and discussed.

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The effect of varying Cu2+ concentration on the structure and optical properties of BaAl2O4: x% Cu2+ (0 ≤ x ≤ 1) nano-phosphors prepared using the citrate sol-gel method

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BaAl2O4:x% Cu2+ (0 ≤ x ≤ 1) nano-powders were successfully synthesized via citrate sol-gel method. The X-ray diffraction (XRD) spectrum revealed that the prepared BaAl2O4:x% Cu2+ samples consists of the hexagonal BaAl2O4. The estimated average crystallite sizes from the XRD and transmission electron microscopy (TEM) were found to be in the order of 20 nm. The energy dispersive X-ray spectroscopy (EDS) confirmed the presence of all expected elementary composition (Ba, Al, O and Cu). The scanning electron microscope (SEM) showed that varying the Cu2+ concentration influence the morphology of the prepared nano-phosphor. The photoluminescence (PL) showed the presence of both emissions from the host material and Cu2+. Two emission peaks located at 440 – 500 and 616 nm were attributed to the intrinsic intraband gap defects within the host material, while the emission at 424 – 475 nm were attributed to arise from the 3d84s1 ⟶ 3d9 transition in Cu2+. The critical energy transfer distance (Rc) of Cu2+ ions was found to be 12.01 Å, suggesting that the multipole–multipole interaction (M-MI) caused the concentration quenching. The International Commission on Illumination (CIE) colour chromaticity showed that varying the Cu2+ doping concentration and excitation wavelength significantly influences the emission colour. Thermo stimulated luminescence (TSL) shows the present of two glow peaks at 90.5 and 100 °C for the host and doped sample, respectively.

Nuclear, Particle and Radiation Physics / 296

The search for a new scalar and a dark force boson

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The Large Hadron Collider's (LHC) most significant discoveries are: firstly a Higgs Boson (discovered on July 4, 2012) and secondly no physics beyond the Standard Model (BSM). This is despite the fact something BSM is so well motivated from especially astrophysics and theoretical considerations. Searches must become more powerful and extend to regions not yet covered. This paper describes a new search for a scalar particle decaying ultimately to Standard Model (SM) leptons, through a dark vector boson intermediate state. The progenitor could be Higgs-like, but is motivated more generally, by a dark sector, a 2HDM type approach, or the search may simply be model independent. The processes under consideration is S ⟶ XX ⟶ 4l where X is the dark vector boson Zd and S is the new scalar. The mass range under consideration for the new scalar is from 20 GeV to 1 TeV, excluding a window around the SM Higgs. The mass range of the dark vector boson is from 10 GeV to 500 GeV, excluding the SM Z. The search will use the available large dataset the LHC has collected during it's second run (Run 2) which took place between 2015 and 2018 and has 150 fb-1 of data.. The talk discusses the motivation of the analysis, the search strategy, and the validation of the search strategy.

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Poster Session 2 / 297

Fabrication of of NV centers in diamond

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Solid-state based single photon systems are at the heart of the second quantum revolution. There is great interest in research focusing on structurally embedded color centers in diamond, particularly NV^- centers. It has been shown that the excitation of these color centers generate non-classical states on demand, applicable in quantum information processes. Consequently, the emission properties of NV^- centers in diamond has been studied extensively over the years and show great promise in the ongoing pursuit of successfully manufacturing quantum based technological devices. In this study, we engineer NV^- centers in well-defined isolated regions within a pure type IIa diamond sample via ion implantation. We then characterize the fluorescence and photon distribution from a single fabricated color center. Ultimately, this will allow us to engineer isolated NV^- centers, depending on application, at desirable regions within a given sample.

Poster Session 2 / 298

Electronic and Optical Properties of Ru and Pt Doped TiO2 Brookite Surfaces Using Density Functional Theory

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The electronic structures and optical properties of brookite TiO2 (210) surfaces doped with transition metals (Ru and Pt) have been investigated by first-principles calculations based on the density functional theory employing generalized gradient approximation (GGA). The modelled surface structures were constructed from an optimized brookite bulk structure. TiO2 surfaces were doped with transition metals, with one Ti atom replaced by a transition metal atom. The results indicate that both transition metals doping can narrow the band gap of TiO2, leading to the improvement in the photo reactivity of TiO2. The metal dopants shift the absorption to high wavelengths and improves optical absorbance in visible and near-IR region.

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Estimation of reference Evapotranspiration (ET0) using temperature data for Nwanedi area, Vhembe district Municipality, Limpopo Province, South Africa.

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Quantification of reference evapotranspiration (ETO) for a particular area is necessary in many applications in agriculture like, crop production, water resources, scheduling of irrigation, environmental assessment, etc. Estimation of evapotranspiration is one of the major hydrological components for determining the water budget, and components for determining the water flow analysis. The Nwanedi small scale rural farming area is developing in different farming categories which lead to the use of more water in the area. In the current study two models have been selected to estimate the evapotranspiration of Nwanedi area using temperature data obtained from the ARC Nwanedi station. Comparison between the estimated and the measured evapotranspiration was performed using the two proposed models. Using the solar radiation based method we obtained the maximum monthly average value of 4.735 mm/d compared to a value of 4.770 mm/d in the month of January 2009 and the minimum value of 2.776 mm/d compared to 2.658 mm/d in the month of July 2009.

Poster Session 2 / 300

Synthesis and Characterization of α-Fe2O3 nanorods arrays for Hydrogen Production

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Since the discovery of Iron Oxide, several phases of it have been realized. A thermodynamic stable phase of Iron Oxide from a natural occurring water photo oxidation. This work seeks to enhance the band gap and the conduction edge to the required values in order to attain this phase akaganiete (β-FeOOH) is hematite (α-Fe2O3) and it has attracted much attention because of its great advantages, such as thermal stability, Photo-corrosive resistance and Photo-catalytic. The major advantage of hematite is its ability to form a 1-D type nanorods structure via self-assembly mechanism. This type of nanostructure has a better electrical transport property and a band gap of 2.2 eV. Therefore, due to these properties it is a promising candidate for water splitting application. This work focuses on nanorods of hematite for hydrogen production by splitting of water but the setback is the fact that the band gap of these rods is limiting the application of it in water splitting. This is due to the fact that water splitting requires a band gap of 2.46 eV with and without external bias. Therefore, a blue shift of 0.3 to 0.6 eV on the band gap and simultaneous upward shift on the conduction edge would make hematite a good candidate.

Poster Session 2 / 301

THE EFFECT OF VARIABLE MICROWAVE POWER ON THE LOW-FIELD ABSORPTION IN NANO NICKEL ADDED TO YBCO POWDER

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Measurement of microwave properties of high Tc superconductors (HTSC) has fundamental physical and technological relevance. HTSC are granular in nature and contain many Josephson junctions or weak links. We have measured the microwave response of NI-YBCO powder, using low field dependent microwave absorption (LFDMA) technique. The existence of peaks in LFDMA is well-established while dependence of peak position (Hm) on temperature is not very dear. The origin of LFDMA in HTSC has been a subject of continued debate. The model proposed by Dulcic et al., with modification explains the most of the observations of LFDMA. The model is based on the microwave loss mechanism in the single representative resistively shunted Josephson junction.

Poster Session 1 / 303

Investigation of cave air ventilation and CO2 outgassing by radon-222

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Knowledge of cave ventilation processes is required to quantify the effect variations in CO2 concentrations which have on speleothem deposition rates and thus paleoclimate records. In this study we use radon-222 (222Rn) as a proxy of ventilation to estimate CO2 outgassing from the cave to the atmosphere, which can be used to infer relative speleothem deposition rates. We have measured radon concentration from Cango Cave, a tourist cave preserve in Oudthroun, Western Cape Province, South Africa using Electret ion chamber and Rad 7 in order to excess radon migrated from cave soil and drip water. Average cave air 222Rn concentrations vary seasonally between winter (222Rn=50 dpm L−1, where 1 dpm L−1=60 Bq m−3; CO2 =360 ppmv) and summer (222Rn=1400 dpm L−1; CO2 =3900 ppmv). Large amplitude diurnal variations are observed during late summer (222Rn=6 to 581 dpm L−1; CO2=360 to 2500 ppmv). We employ a simple first-order 222Rn mass balance model to estimate cave air exchange rates with the outside atmosphere. Ventilation occurs via density driven flow and by winds across the entrances which create a 'venturi' effect. The most rapid ventilation occurs 25 m inside the cave near the entrance: 45 h−1 (1.33 min turnover time). Farther inside (175 m) exchange is slower and maximum ventilation rates are 3 h−1 (22 min turnover time). We estimate net CO2 flux from the epikarst to the cave atmosphere using a CO2 mass balance model tuned with the 222Rn model. Net CO2 flux from the epikarst is highest in summer (72 mmolm−2 day−1) and winter (12 mmolm−2 day−1). Modelled ventilation and net CO2 fluxes are used to estimate net CO2 outgassing from the cave to the atmosphere. Average net CO2 outgassing is positive (net loss from the cave) and is highest in late summer and early autumn (about 4 mol h−1) and lowest in winter (about 0.5 mol h−1). Modelling of ventilation, net CO2 flux from the epikarst, and CO2 outgassing to the atmosphere from cave monitoring time-series can help better constrain paleoclimatic interpretations of speleothem geochemical records.

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Higgs Production through Gluon Fusion via intermediate Top quark loop

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Beginning with a brief discussion on the spontaneous symmetry breaking of global and local symmetries, the amplitude for production of Higgs boson via the most dominant channel, i.e., gluon fusion, has been calculated. The expression for the amplitude in terms of general arbitrary top quark masses give rise to some dilogarithmic integrals, which can be difficult to evaluate, and hence, the limit when mass of top quark >> mass of Higgs boson has been chosen. It is found out that even for cases in which the mass of the top quark is about 30% more than the mass of the Higgs boson, the integral remains almost insensitive to the mass of the top quark,i.e., with changing top quark mass, the value of the amplitude remains the same. This validates the calculations done in the selected limit.

Physics of Condensed Matter and Materials / 306

Overview of photoemission spectroscopy as a tool for electronic structure investigations of materials

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Investigating the electronic structure of solid materials is a very powerful tool to get insights into the oxidation state, composition, chemical bonding, binding energies and correlation effects, as well as the low-energy electronic band structure and the Fermi surface of these materials. Such investigations are carried out experimentally by exploiting a technique named photoemission spectroscopy, which gives access to the either the deep core levels, in case of X-ray photoemission spectroscopy, or the low-energy valence band states, in case of UV photoemission spectroscopy and angle resolved photoemission spectroscopy.
In this lecture, I will first talk about the basic theoretical principles of this experimental technique, namely the three-step model of photoemission in solids, the single-particle energy diagram, conservation of energy and momentum and matrix elements. I will then move on to discussing the features of photoemission spectra that carry the relevant information on the properties of solids, such as spin-orbit splitting, chemical shift, peak line shape and satellites. I will then conclude my presentation by presenting a summary of recent interesting results, which show that electronic structure investigations find diversified applications in condensed matter physics, surface science, nanotechnology, semiconductor devices, materials engineering, chemistry, catalysis, water purification and geology.

Poster Session 1 / 307

Geant4 in a new role – Reactor Physics

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The accurate modeling of nuclear reactors is essential for design, regulation, safety analysis, operations and forensic analysis. There are two classes of approaches to modeling the neutronics of nuclear reactors. The first is deterministic, where the neutron transport equations are solved using a combination of approximations and numerical methods based on a space-time discretization. This approach currently dominates where computing speed and resource limitations apply. The second class of models is stochastic in nature. Here many statistically independent histories for each neutron event and all secondary events related to its interactions are tracked and various physical data is stored for later statistical analysis. This paper presents several results that establish the proof of principle in the stochastic Monte Carlo (MC) modelling of a nuclear reactor core using the Geant4 framework. The simulation is exercised in the context of a High Temperature Gas Cooled Reactor (HTGCR) with pebble fuel and helium coolant. MCNP and SERPENT are better known codes in this context, however Geant4 promises to be a significant additional coding framework. It has a modern C++ modular architecture, it is multi-threaded and trivially parallel on multiple nodes, the well documented source is readily available. Rather than being input card driven the user modifies and extends the class structure. It has excellent engines for geometry, materials, physics, tracking, history recording, visualisation and the analysis is readily done with additional frameworks such as ROOT. In this paper we review the implementation of the following aspects in proof of principle form : the basic neutronics (thermailisation and containment), validation of the databases (elementary neutron induced reactions), scalability, thermal neutronics, geometrical discretisation for studying the spatial variation of physical parameters, time slicing and adaptation of Geant4 for correct intra-slice persistence, a scheme of integration with thermal hydraulics by workflow scheduling, the process of fission, burn, decay, and differential energy depositions for the various physics processes, validation of the Xenon effects on the neutronics, criticality and core follow over multiple time steps. The benchmarking programme against MCNP and Serpent is also discussed.

Poster Session 1 / 308

Low Dose Radiation damage in diamond

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Radiation damage is of great interest in diamond. Diamond is so-called radiation hard and is a candidate for passive and active electronics in high radiation environments. Further, it is possible to treat diamond by radiation and annealing stages, so as to change its color or introduce a favoured colour. The studies of radiation damage is therefore well advanced in diamond. More recently, so called “quantum diamond” is engineered by a low dose damage and ion implantation process. Our own interest in the matter of radiation damage in diamond arises from natural diamond recovery using the MinPET technique. This has a high energy photon irradiation stage to produce internal Positron Emission Tomography (PET) emitters, whose subsequent transient PET radiation yields 3D quantitative local carbon density distributions within kimberlite rock. We have therefore made a study of radiation damage in diamond in the limit of very low dose derived from a high energy mixed radiation field of photons and electrons. The process has also been modelled using Geant4. The major mechanism for displacement of carbon atoms is ballistic collisions derived from the primary and secondary electrons. One must also consider the damage due to the secondary carbon recoils. Then there is the various nuclear reactions and the secondary consequences of these. The primary damage creation is the single neutral vacancy (GR1 defect). There is also the primary interstitials which can be the single dumbell interstitial on cubic face centre (R2 defect) or the self-trapped pair of these (R1 defect). Finally there can be aggregates of these defects with each other as well as with pre-existing defects in the diamond (if there were present not too far from the radiation induced defect). As most of these defects are optically active, measurements were performed using UV-VIS absorption spectroscopy, IR absorption spectroscopy very sensitive photoluminescence (PL) spectroscopy at 77K. The results will be presented and discussed.

Theoretical and Computational Physics / 309

Relativistic Bell correlations and accelerations

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In quantum mechanics, the phenomenon described by the situation of two particles correlated in such a way that when the spin of one is measured, the other is immediately known, is called quantum entanglement. This phenomenon was first described by Einstein in an argument put forth in the now famous EPR paper to express his misgivings and what he saw as the fundamental problems with quantum mechanics. Einstein believed that one should be able to describe the correlations in the context of classical local realism. The debate was largely philosophical until John Bell, in 1964, wrote a paper that proposed a way to settle the matter experimentally. Bell, derived an inequality, now called the Bell inequality, which holds for all such correlations that can be described by classical local realism and put forward what is now called Bell's theorem. Quantum mechanics itself predicts that Bell's inequality should be violated, which it is as shown by experiment. However, Bell only calculated the theorem in the case of non-relativistic quantum mechanics. More recently, there have been some authors who have found that the Bell correlations would be modified in relativistic frames, although the maximal violation of Bell's inequality is still preserved in a different set of directions. The directions in which the maximal violation of Bell's inequality is conserved in the relativistic frames are rotated with respect to each other from the usual non-relativistic case through an angle called the Wigner angle. The Wigner angle is related two the velocity of one inertial frame with respect to the centre of momentum frame of the two particles. If such an effect on the correlation between the two particles can be observed between two inertial frames then it stands to reason that a precessional effect could be observed on Bell observables if the particles are accelerating. This precessional effect is called the Thomas Precession and we argue that we could possibly use it to detect forces between the particles.

Poster Session 1 / 311

THERMOCHEMICAL CHARACTERIZATION AND SUITABILITY OF ANIMAL HORNS FOR CARBONITRIDING TREATMENT

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Cow horns and hooves are abattoir wastes which have not been properly managed hitherto and their indiscriminate disposal amounts to environmental risk and pollution. However, in this work, thermochemical characterization of animal horns has been carried out to investigate their potential for carbonitriding treatment of steel. Thermogravimetric analysis (TGA) was carried out to investigate thermal behaviour of horns. Energy dispersive X-Ray spectroscopy (EDS) and Raman spectroscopy were carried out for quantification and qualification of the elements present in the horns while X-ray diffraction (XRD) was done to examine the phases present. Carbonitriding heat treatment of AISI 1018 steel was then carried out with cow horn, at 850 °C and 450 °C for carburizing and nitriding dominated processes, respectively. Vickers hardness measurement and optical microscopy were carried out on carbonitrided samples to examine the hardness profile and phase contrast in the samples following heat treatment. Thermochemical analysis revealed the presence of volatile matters and residues of up to 83% and 17%, respectively. The results of EDS confirmed presence of carbon and nitrogen in significant amount in all samples. The hardness results revealed profile indicating higher hardness value at near surface and decreasing towards the core. The suitability of animal horns for carbonitriding treatment of steel would ensure value addition and waste diminution in environment.

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Theory of equation of state and transport coefficients for relativistic hydrodynamics in Heavy Ion Collisions and Binary Neutron Star Collisions

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I will give a review of the nuclear equation of state and transport properties of matter in heavy ion collisions (HIC) and binary neutron star collisions. I will also point out the significance of the equation of state (EoS) and transport coefficients for HIC and astrophysical observables.
I will try to focus on general methods and principles but also touch on specific open questions for future research.

The observation of Neutron Stars and Binary Neutron Star Collisions allows us to constrain the equation of state(Eos) and transport coefficients of the dense matter well beyond the densities available in earth laboratories such as those colliding heavy ions.
The recent observation of gravitational waves GW170817 and its electromagnetic counterparts allows us to constrain the dense matter Eos and transport coefficients in new and complementary ways.

The macroscopic properties of neutron stars depend on how sub-atomic particles interact in their interiors. These interactions are encoded in the equation of state and transport coefficients.

Finally, I will briefly comment on gravitational waves as a signature of quark matter formation in LIGO and SALT/MeerKAT/SKA detection and observations.

Poster Session 2 / 313

Computational modelling of TiO2/SnO2 interfaces for energy storage

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Energy storage devices such as rechargeable lithium-ion batteries are considered as reliable energy storage devices for portable electronic devices, electric vehicles and key enabling devices. This is due to their high energy density, lightweight, long lifetime, environmental benignity and high efficiency. In this work, we make use of hybrid density functional theory to study the electronic properties of (1 1 0) and (1 0 1) TiO2 and SnO2 interfaces. Tin oxide has been considered as one of the most appealing and promising materials with high theoretical capacity for anode materials used for lithium-ion batteries whereas TiO2 provides SnO2 with secondary structure protection in the SnO2/TiO2 interfaces. A detailed analysis was conducted from first principles calculations by making use of plane-wave pseudopotential density functional theory within the generalised approximation for the exchange-correlation functional. It was found that the band positions of both TiO2/SnO2 interfaces change as compared to individual systems and become broader. Also the electronic properties were investigated, i.e. analysis of the total and projected density of states, and charge density differences of the TiO2/SnO2 interfaces. The findings provide a useful information on understanding the interfacial mechanisms for energy storage materials.

Astrophysics / 314

The interpretation of broadband data from radio pulsars

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Profiles from radio pulsars typically show a strong dependence on observing frequency. This depends both on the intrinsic radio emission mechanism, as well as the interaction of the radio waves with the interstellar medium (ISM) that lies between the pulsars and our detectors on Earth, due mostly to the effects of dispersion and scattering. The aim of our project is to study how to best extract information on pulsar profiles and the ISM, using the wide frequency bands that are typical of radio telescopes today. We make use of radio pulsar emission models to simulate pulse profiles. Basic radio pulsar geometry is used, assuming that pulsar emission comes from a set of open magnetic-field lines above the neutron star's surface, with high frequencies emitted in regions closer to the neutron star and low frequencies from high altitudes further up the field lines. Depending on the line-of-sight cut and the radio frequency of observation, which are both chosen for each simulation, the generated profile may comprise of overlapping components that are approximated to first order as Gaussians. With this information we simulate pulse profiles representing data from telescopes observing at various centre frequency bands, covering bands from 30 MHz up to 1.7 GHz, and with a variety of corresponding bandwidths for each pulsar beam model. The results show that intrinsic profile evolution with frequency can be interpreted as an additional component to the dispersion measure (DM), the frequency dependent delay of the radio emission normally associated with dispersion in the ISM. In addition, this DM correction will be frequency dependent, unlike the ISM induced DM. We discuss the systematics introduced to pulsar data due to this effect.

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APPLIED PHYSICS AGM

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Theoretical and Computational Physics / 321

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Applied Physics / 322

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Effect of neutron irradiation on the structural, electrical and optical properties evolution of RPLD VO_2 films

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Vanadium dioxide (VO_2) is explored as an active smart radiation device (SRD) for new type of thermal control material for space craft especially in small satellites such as CubeSats. Current space thermal control systems require heaters with an additional power penalty to maintain moderate spacecraft's temperatures during extreme temperatures. Because its emissivity can be changed without electrical instruments or mechanical part, the use of VO_2 based thin films decreases the request of spacecraft power budget. As an active smart radiator device, an ideal VO_2 based nano-coatings should have a low emissivity at low temperatures to maintain the heat, whereas at high temperatures its emissivity should be high to dissipate the additional unnecessary heat [1,2]. In addition to their active thermal management properties, these VO_2 coatings must exhibit deep space radiations hardness. while in outer space such coatings will be exposed to different cosmic radiation including neutrons. Because these radiations interact with the material in different ways, this contribution reports on the study of VO_2 coatings properties subjected to neutron irradiation with typical energy and doses to space missions. The induced defects on the properties of VO_2 thin films have been investigated using electrical, optical and structural measurements. Both Raman and the grazing incident angle X ray diffraction analysis show that no structural transformation is induced by neutron irradiation, although the grain size formation along the preferential orientation is affected. According to X-ray photoelectron spectroscopy, resistivity and work function measurements, the charge carrier (electron) concentration at room temperature decreases after irradiation. Taking into account that (i) fast neutron irradiation induced defects are mainly a series of Frenkel pairs defects, swelling and disordered regions in VO2 thin films without amorphization and (ii) resistivity and THz transmission measurements confirm that the characteristic semiconductor to metal transition of the VO2 films is preserved upon irradiation, we conclude that VO2 is an excellent candidate for thermal shielding and thermal management of small satellites.

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An overview of iThemba LABS cyclotrons and ion sources

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Production of metal ion beams with the iThemba LABS ECR ion source

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Beam intensity improvement of high energy heavy ions beams at iThemba LABS

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Fluka Monte Carlo simulation of gamma photon transport through a distillation column, designed usingChemSep software

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Monte-Carlo Shielding Calculations for a 10-MeV Electron Accelerator in Botswana

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Geant4 in a new role – Reactor Physics

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Design of a national indoor radon survey for South African Homes: review of existing indoor radonconcentration data and associated measurement techniques

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Radioactivity assessment of Uranium Isotopes concentration in water sources at and near selected formeruranium mines in the West-Rand area of Johannesburg

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Determining the Radon Emanation Coefficient for soil sample.

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Study of total, complete and incomplete fusions

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Angular correlation measurements with a segmented clover detector

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Developing Nuclear Forensics Signatures in the Southern African Region: A case study of South Africa and Namibia

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Toxicity of Natural Radioactivity in Water Samples from a Gold Mine in Gauteng Province, South Africa

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New Collective Structures in the Z = 76 Stable Odd Neutron Nucleus 187Os

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Search for collective structures in 186Os

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Industry-Academia Collaborations – Case Study of Diamond Sorting Industry

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Physics outside Academia (Mikhail Sakharov)

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Financing a Start-up and the Role of National Empowerment Fund in Entrepreneurship Support in South Africa (NEF Rep)

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Intellectual Property, Innovation Management and the Role of NIMPO in Innovation Support in South Africa (NIPO)

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Discussion of Improving the Physics in Industry

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Wonderful" Stars

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As stars like the Sun age they undergo various dramatic changes. I will review what we know about the last stage of stellar evolution that is powered by nuclear fusion; know as the Asymptotic Giant Branch (AGB) phase. These extraordinary stars can be intrinsically a thousand times brighter than the Sun, and are a major source of elements, such as carbon, that will form new planets and even contribute to living creatures. The mass-loss process by which this material leaves the star is still poorly understood and is a focus of new theory and a variety of observations using telescopes around the world, including those in South Africa, and in space. A subgroup of these AGB Stars, the Miras (Latin for wonderful), are strongly variable, regularly changing their visual light output by a factor as much as a thousand times, on time scales ranging from one hundred to several thousand days. These Miras also have properties that make them useful distance indicators, as observations from SAAO have demonstrated. They will potentially be important to future studies of the distance scale of the universe using the James Webb Space Telescope and the next generation of extremely large ground-based telescopes.

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Particle Physics and Climate Change

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Accelerator Mass Spectrometry (AMS) is an applied particle physics technology that is playing an important role in understanding the trajectory of climate change in southern Africa. The Inter-governmental Panel on Climate Change (IPCC) advocates the use of past climate history as a test of the skill of climate models, but the instrumental record of climate variability in southern Africa is short in duration and patchy in distribution. An approach to climate reconstruction where instrumental records are inadequate is dendrochronology: the recording of climate in the ring widths of trees, but in southern Africa this approach is limited to short-lived tree species. At iThemba LABS we have been attempting to reconstruct past climate using the isotopic chemistry of wood from long-lived trees. The focus has been on baobab trees that can achieve ages in excess of 1000 years, but the ring structures preserved in the wood are not annually formed. Understanding the growth structure of the trees is critical to climate reconstruction. By measuring the rare isotope ^{14}C using AMS it has been possible to radiocarbon date baobabs. The approach is complicated by the "Suess Effect" where atmospheric ^{14}C levels were diluted by the addition of "^{14}C-dead" fossil fuel carbon to the atmosphere since the start of the industrial revolution. It is also complicated by the effect that above ground nuclear testing had on ^{14}C concentrations in the atmosphere. These effects are overcome and the results show that baobab growth is complex, but it can be unraveled with AMS dating. By measuring the stable isotope ratios ($^{13}C/^{12}C$) of the baobab wood, it has been possible to reconstruct rainfall variability over southern Africa from Namibia to Madagascar over the last 600-1000 years. This record reveals the underlying forcing of climate, and approximately 4 variables control most of the droughts (including the "day-0" drought in Cape Town) in the region. Using this to test climate models shows that the models accurately predict the effects of the 4 underlying variable, and so the alarming climate change forecasts for the region should be given high priority at policy level.

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Computational modelling as a value-add in materials design and discovery

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Computer modelling has been identified as a key area of growth worldwide and is increasingly becoming a driving force in the discovery and design of novel materials. Currently, computer simulation methods are influencing all areas of study, with a great impact in condensed matter physics, materials science, chemistry and engineering. With the advancement of computing powers, complex materials and their properties are increasing investigated. Methods at different spatiotemporal scales such as density functional theory, molecular dynamics, energy minimization, many-body perturbation theory, phase field and quantum Monte Carlo to continuum macroscopic approaches are employed to simulate materials for various applications. The search to improve andoptimize properties and structural characterization of materials is a subject of intense scrutiny. However, this has proved challenging because of the complex and preparation-dependent microstructure of many materials. Over the last few years, materials science research have been steadily moving from technique development and determination of fundamental properties towards new materials discovery and design guided by computation, machine learning and data mining, also by a closely tied combination of computational predictions and experimental validation. Thus, thedesign of materials by computation is expected to lead to the discovery of new material and rapid evolution of new materials into products. This talk will broadly highlight recent advances in materials design and discovery, including the application of machine learning techniques in materials science.

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A review of progress on third-generation photo-voltaic cells,

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A review progress on third-generation photovoltaic cells, are solar cells designed toovercome the Shockley–Queisser limit of 31–41% power efficiency for single bandgap solar cells. These cells are not widely commercially available unlike silicon p-n junction cells b("first generation") and thin film cells ("second generation"). Third-generation cells are made using inexpensive and scalable manufacturing techniques, such as solution processing, but are far less stable than silicon PV. They are either relatively high in efficiency (perovskites cells) or made from non-toxic materials (organic cells), but rarely both. The main focus of my talk will be on how the physics of organic and perovskite cells determines the strengths and limitations of these two technologies.

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African Astronomical Society & IAU GA2024

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SKA HCD Programme and Research Highlights

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Physics for all: Rebuilding our community for everyone

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Physics is an objective and precise science. We are careful to not allow our or anyone else's personal biases, emotions, or cultural influences to effect interpretations of data, characterising the scientific method. However, in the past, and it could be argued still today, we do allow these vices to affect the way we think about the people doing science, be them ourselves or others. This can cause problems for minority groups in physics, such as women, by not only encountering prejudice, and from lack of confidence, but also due to systems that were designed to suit a specific type of scientist, traditionally who are male. There are many other factors that cross-correlate, such as economic background, geographic location, and ethnicity, that have similar battles but manifested in different ways. This talk will explore these issues, with some focus on South Africa, and look to how we can become more scientific, in our approach to people, as we are to our data.

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Reporting on the findings of Physics scientometric study

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Storms from the Sun: The Science of Space Weather

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Space Weather is an emerging field of space science that studies how the Sun influences the Earth's space environment and the impacts of those interactions on technology and society. Some of the most intense interactions can damage our Earth-orbiting commercial and scientific satellites; threaten astronaut safety; introduce high levels of radiation for crews and passengers in flights crossing over the poles; disrupt electric power grids, oil pipelines and the reliability and accuracy of global communications and navigation systems, including Global Navigation Satellite Systems (GNSS). With society's ever-increasing dependence on space-based technology, it is important to enhance public awareness of Space Weather, its potential impacts and what governments are doing to enhance forecasting and mitigation of its most damaging effects. This presentation will introduce the basic physical concepts of the source of Space
Weather. This includes information on the Sun, solar wind, eruptive solar phenomena, magnetosphere, ionosphere and geomagnetic induction. The presentation will continue with a view of the impacts of Space Weather on technological systems in space and on the ground. Finally, we will introduce plans to advance forecasting capabilities and mitigation of Space Weather.

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Opening and welcome

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Basic concepts in Photovoltaic

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Review of organic solar cells Historical perspective Recent development and concept improvement

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Physics of new materials for nano-sensors and photovoltaics

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Materials for hybrid organic-inorganic devices

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Renewable Energy Markets and technologies: An overview

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Closing Remarks

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Electronic stopping force of 16O and 63Cu ions in Tantalum Nitride thin films by Time of Flight spectrometry

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Internal conversion coefficients from conversion electron sources

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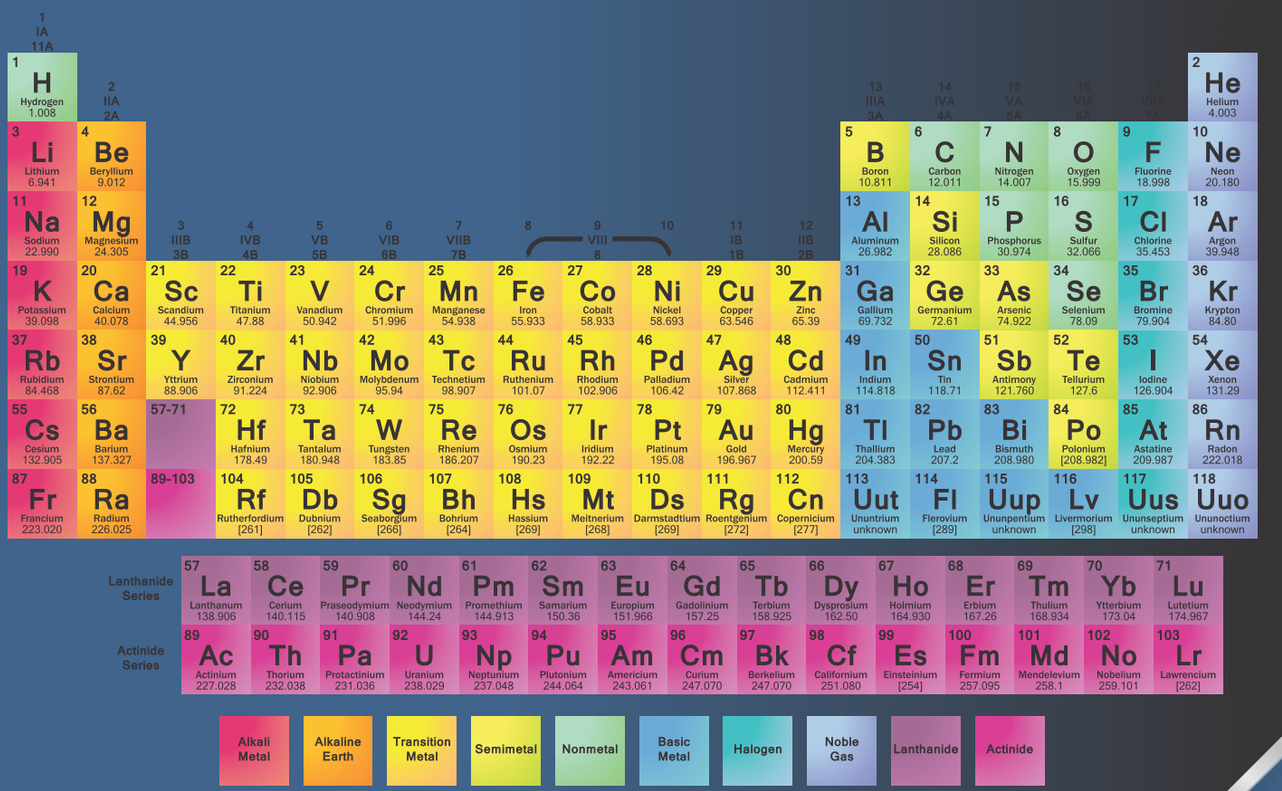
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