SAIP2017

Monday 03 July 2017 - Friday 07 July 2017

Book of Abstracts

Contents

0

Nanotech distruptions in the economy

Authors: Brian Masara[1]; Brian Masara[1]

[1] *SAIP*

Corresponding Author: brian.masara@saip.org.za

- Venue Booked: Engineering building
- IT: IT in Eng available WiFI, Eduroam + access for students through Uni system
- Accommodation: Hostel booked
- List of provisional invited speakers: Attached current status
- Winter Schools: Photonics, Photo voltaic, Teacher??
- Provisional Budget and proposed registration fees: Attached

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

1

Nanotech distruptions

Author: Brian Masara[1]

[1] *SAIP*

just testing

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Hons

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Space Science / 4

Solar Wind And Heliospheric Magnetic Field Behaviour During Solar Cycle 23-24

Author: Pieter Kotze[1]

[1] *SANSA*

Corresponding Author: pkotze@sansa.org.za

Magnetic field and solar wind particle data from the ACE satellite will be used to perform a spectral analysis of the solar wind charge state ratios, e.g. O7+/O6+ and C6+/C5+ as well as the alpha to proton abundance ratios during solar cycle 23 and 24. These oxygen and carbon charge state ratios are a proxy for the electron temperature in the solar corona while the solar wind elemental composition abundances are related to processes in the source region of the solar wind. As the solar corona expands and collision rates drop, these properties are then embedded into the solar wind plasma and contrary to the solar wind velocity, do not evolve as the solar wind travels to 1 AU. Solar wind composition observations and measurements by ACE at 1 AU therefore encapsulate imprints of the conditions under which the solar wind formed. Lomb-Scargle and Morlet wavelet spectral analysis techniques will be used to investigate the evolution of several periodicities of solar wind parameters during cycle 23-24, particularly the unusual minimum between these cycles. Pearson correlation analysis between ACE magnetic field observations and solar spherical harmonic coefficients as a function of the 27-day Carrington rotation also reveals that the sectorial solar magnetic is dominating during the minimum 23-24, indicating an unusual configuration of the solar dynamo.

Summary:

Lomb-Scargle and Morlet wavelet spectral analysis techniques have been used to investigate the evolution of several periodicities of solar wind parameters during cycle 23-24, particularly the unusual minimum between these cycles.

Applied Physics / 5

Computing the diffuse and direct components of global solar irradiance on a horizontal surface in South Africa

Author: LUTENDO CHRISTOPHER NETHWADZI[1]

Co-author: Hartmut Winkler [2]

[1] *SAAPMB*

[2] *Dept. Physics, University of Johannesburg*

Corresponding Author: thwadzi@gmail.com

Most solar radiation measuring devices only determine the total irradiance on a horizontal surface, but for various applications diffuse and direct components are also needed. Because of this, several models have been developed to establish the correlations between the diffuse fraction and various predictors. This paper analyses the measured global irradiance at a Gauteng location as a function of the relative solar position. An equation is presented to estimate both components from the measured daily global solar irradiance only. In this equation, the diffuse component is related to the product of the cosine of the zenith angle and the Linke turbidity factor. The analysis attempts to reproduce the measured irradiance through basic modelling of the spectral opacity of the atmosphere in terms of the Linke Turbidity. This includes estimating direct beam attenuation and the diffuse component, which are then combined with the panel spectral response in an attempt to match the measured and modelled energy yield. The performance of the model have been graphically and statistically analyzed by two established methods, namely; Mean Bias Error (MBE) and Root Mean Square Error (RMSE).

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof. H. Winkler (hwinkler@uj.ac.za). University of Johannesburg

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Poster Session 1 - Board: 73 / **6**

Creating and Optimizing a Sky Tessellation Algorithm for Direction-Dependent effects

Author: Antonio Peters[1]

[1] *Rhodes University MSc Student*

Corresponding Author: apeters@ru.ac.za

With the promise of the SKA comes multiple challenges in terms of capturing and cleaning the data. One part of this involves breaking up or tessellating an image so that it can be cleaned of noise for better analysis. While methods to do this are currently in circulation, more can be done to ensure the results are as accurate as possible and are obtained as quickly as possible.

This research seeks to improve the current best tessellation model for correcting the noise and do so in an optimal way with specialised hardware. To achieve these aims a novel algorithm is created and tested to generate the tessellation more effectively than the current best model. In order to increase the calculation speeds, part of this algorithm is then parallelised for processing on a GPU.

The tessellation algorithm generated for this research is more effective than the current best model in general. Through accelerating parts of the algorithm on a GPU, speed-ups of up to 39.96x are obtained for tessellations generated from 1000 data sources.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Hons

**Main supervisor (name and email)
and his / her institution**:

Prof. K. Bradshaw k.bradshaw@ru.ac.za Rhodes University
Prof. D. Pollney d.pollney@ru.ac.za Rhodes University
Prof. O. Smirnov o.smirnov@ru.ac.za Rhodes University/SKA SA

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Applied Physics / **7**

Simulation of Ground Level Spectral Solar Irradiance in Rwanda using LibRadtran.

Author: MARIE CHANTAL CYULINYANA[1]

Co-author: Hartmut Winkler [2]

[1] *Department of Physics, University of Johannesburg*

[2] *Dept. Physics, University of Johannesburg*

Corresponding Author: kamirwa@gmail.com

Optimising solar power development in Rwanda requires accurate knowledge of the spectral distribution of solar irradiation reaching the Earth's surface at different wavelengths. To characterize the effect of aerosols on surface solar irradiance, the simulation of a cloudless atmosphere is presented in this study. The irradiance spectrum is obtained by solving the radiative transfer equation for this aerosol distribution using established radiative transfer codes. The results show a spectral distribution simulated using LibRadtran, which is one such software package. Its main program, UVSPEC is a radiative transfer tool mainly used to compute radiances, irradiances, and actinic fluxes in the solar and thermal spectral regions.
The aerosols properties are furthermore investigated through comparison with archival sunphotometry data from the region and their effect on the surface solar radiation. It is then shown how the outcome of this calculation may be used to estimate local energy yield.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. Hartmut Winkler
Physics Department
University of Johannesburg

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Poster Session 1 - Board: 01 / **8**

FTIR assessment of In_xGa_{1-x}As

Author: Sarah McKee[1]

Co-authors: Ernest Van Dyk [2]; Ettienne Minnaar [2]; Japie Engelbrecht [2]

[1] *NWU*

[2] *NMMU*

Corresponding Author: japie.engelbrecht@nmmu.ac.za

The binary In_xGa_{1-x}As alloy finds application as HEMT transistors, laser and photodiodes, triple-junction photovoltaic devices and infrared detectors, due to its advantageous band gap, which varies from 0.36 to 1.425 eV. It is thus important to determine the bandgap of grown layers in order to engineer and control the optical properties of grown epilayers of In_xGa_{1-x}As.

Five In_xGa_{1-x}As epilayers grown by metallorganic vapour phase depositioning (MOCVD) were assessed by reflectance Fourier Transform Infrared spectroscopy (FTIR). A Bruker 80V FTIR/Raman system, fitted with a horizontal stage sample holder, enabling near-normal incidence of incident radiation, was employed. 100 Scans of each sample were obtained at a resolution of 8 cm-1. Spectra obtained allowed determination of both the band gap from the inflexion point on the spectra, and epilayer thickness from interference fringes. Two theoretical models were used to obtain the required refractive index as function of wavenumber for thickness calculations. Results obtained indicated that the respective band gaps varied between 1.2 – 1.4 eV, while the layer thicknesses varied between 1 and 2 micron. Experimental values are in agreement with information provided by the crystal growers. Results will be presented and discussed.

Summary:

Band gap and layer thickness determination of In_xGa_{1-x}As epilayers using FTIR reflectance spectroscopy.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Nuclear, Particle and Radiation Physics 1 / 9

Characterisation of radon in Karoo Basin groundwater prior to shale gas exploration

Author: Botha Ryno[1]

Co-authors: Peana Maleka Peana Maleka [2]; Richard Newman Richard Newman [3]; Robert Lindsay Robert [4]

[1] *University of the Western Cape and Stellenbosch University*

[2] *iThemba-Labs*

[3] *Stellenbosch University*

[4] *Univeristy of the Western Cape*

Corresponding Author: devalarish@yahoo.com

The prospect of unconventional shale-gas development in the Karoo Basin (South Africa) has created the prerequisite to obtaining baseline data on natural radioactivity in Karoo groundwaters. The key natural occurring radioactive material (NORM) studied was radon (222Rn) in-water activity concentrations; however, supplementary radium (226Ra and 228Ra) in-water activity concentrations and uranium (238U) in-water concentrations measurements were also included. A total of 53 sites across three provinces were sampled for groundwater and measured in the Karoo Basin, with three measurement series from 2014 to 2016. The groundwater was categorized as either shallow, mixed, or deep sources. The radon in-water baseline of the Karoo Basin can be characterised by a minimum of 0.6 ± 0.9 Bq/L, a maximum of 183 ± 18 Bq/L and mean of 41 ± 5 Bq/L. The radon in-water levels from shallow sources (< 20 ℃) were systematically higher (40 Bq/L) than for deep sources (> 20 ℃). The natural fluctuations in radon in-water levels were predominantly associated with shallow sources compared to almost none observed in the deep sources. The uranium in-water baseline can be characterised by a minimum of below detection level, a maximum of 41 µg/L, and a collective mean of 5.1 ± 0.80 µg/L. Similar to radon in-water levels, uranium in-water levels from shallow sources were systematically higher than in deep sources. The limited (six sites) radium (228Ra and 226Ra) in-water activity-concentration measurement results were very low, with a maximum of 0.015 Bq/L (228Ra). The 228Ra/226Ra ratio baseline can be characterised by a minimum of 0.93, a mean of 3.26 ± 1.33, and a maximum of 6.49. The radium isotopes activity concentrations ratio is an isotopic tracer for shale gas and hydraulic fracturing fluids. Pollution and contamination (radiological), due to unconventional shale gas development, in water resources has been noticed in the Marcellus Basin

(United States). Consequently, developing and improving continuous radiological baseline systems are of importance to study the environmental effect of hydraulic fracturing.

Summary:

A novel and most comprehensive study up to date to characterize radon (NORM) within groundwaters of the Karoo. The primary aim of this study is to construct a Karoo Basin groundwater radiological baseline which could serve as a reference to study potential future radiological contamination effects due to hydraulic fracturing.

Poster Session 1 - Board: 43 / **10**

TESTING THE SCATTERING DISTRIBUTION OF A PHOTON IN A TURBID MEDIUM USING MONTE CARLO SIMULATIONS

Author: Thulani Mabhengu[1]

Co-author: Hartmut Winkler [2]

[1] *SAAPMB*

[2] *SAIP*

Corresponding Author: thulani.mabhengu@netcare.co.za

The scattering distribution of a photon in an inhomogeneous turbid medium is too complex to be represented by an analytical expression, and therefore requires a numerical solution. Photon propagation may be treated a stochastic process. In this study, a Monte Carlo simulation is used to reproduce the behaviour of photons in turbid media. This is approached by applying random number generation to the fundamental physics of photon scattering. The redistribution of a photon in different directions is determined through the stochastic treatment of the scattering event and corresponding phase function. Scattered light is then subjected to a repeated similar stochastic process until the photon emerges from the medium. Taking into consideration the physical and optical properties of the turbid media, the model predicts the angular distribution of photons able to transmit through the medium. Archival data obtained from sunphotometry will be used to attempt to validate the simulations

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Main supervisor: Prof. Hartmut Winkler

Email: hwinkler@uj.ac.za

Institution: University of Johannesburg

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Astrophysics / 11

Cosmic ray diffusion and the role of nearby sources in the study of positron excess

Author: Jagdish Chandra Joshi[1]

Co-author: Soebur Razzaque [1]

[1] *University of Johannesburg*

Corresponding Author: jjagdish@uj.ac.za

The flux of positrons observed at Earth produced as secondaries in the cosmic ray nuclei interactions. In the astrophysical scenario positrons are also injected as primaries, and this scenario is very peculiar if these objects are located in the sub-kpc range of solar system. We calculate the positron flux produced by cosmic ray interaction using the DRAGON code, and
also check the nearby source contribution using the diffusion-loss equation. A new population of electron-positron injection from astrophysical sources can account for the positron flux below 100 GeV.

Physics of Condensed Matter and Materials 1 / 12

Electrical levels induced by thulium (Tm³⁺) in germanium: a hybrid density functional study

Author: Emmanuel Igumbor[1]

Co-author: Walter Meyer [1]

[1] *University of Pretoria*

Corresponding Author: elgumuk@gmail.com

In this work we present ab-initio calculation results for the Tm³⁺ interstitial, vacancy-interstitial complex (V_{Ge}-Tm³⁺_i) and substitutional (Tm³⁺<sub>Ge</sub defects as determined by using the Heyd, Scuseria, and Ernzerhof (HSE06) hybrid functional. We calculated the formation energies and the charge state transition levels of different configurations. Our results show that the Tm³⁺_i exists in both the hexagonal and tetrahedral configuration with low formation energy. The interstitial atom is most energetically favourable at the tetrahedral site. The formation energies for the V_{Ge}-Tm³⁺_i and Tm³⁺_{Ge} were as low as 0.84 eV. The most energetically favourable defects were the V_{Ge}-Tm³⁺_i in the axial configuration and the Tm³⁺_{Ge}. The Tm³⁺_{Ge} and V_{Ge}-Tm³⁺_i introduced a single acceptor &epsilon(0/-1) charge state transition level that was positioned deep in the middle of the band gap. The majority of the levels induced by the defects under investigation were either shallow donor or acceptor level lying close to the band gap edges. The charge state thermodynamic transition levels revealed that the vacancy-complex V_{Ge}-Tm³⁺_{Ge} induced shallow levels in the band gap. The V_{Ge}-Tm³⁺_{Ge}displayed evidence of a single donor level &epsilon(+1/0) and an acceptor level &epsilon(-1/-2) within the band gap. Charge state controlled metastability was exhibited by the V_{Ge}-Tm³⁺_{Ge}.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

No

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Poster Session 2 - Board: 80 / **13**

The Efficacy of Computer-Based Laboratory Experiments

Author: Mohapi Thebe[1]

Co-authors: Charle Sunnyboy Maboya [1]; Lehlohonolo Koao [2]

[1] *VUT*

[2] *UFS*

Corresponding Author: mohapit@vut.ac.za

The efficacy of computer-based laboratory experiments was explored as a means through which physics practical work can be enhanced for the benefit of students. The study was conducted with physics students at a South African university of technology. Students enrolled for engineering as well as chemistry and non-destructing testing programs were exposed to computer-based laboratory experiments. Exposure to computer-based laboratory experiments strongly suggests improved efficiency in the running of physics laboratories coupled with enhanced students' conceptual understanding. Implications for teaching and learning are discussed.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Applied Physics / **14**

Surface wave generation by piezoelectric transducer on pesrpex wedges and their interaction with notches in steel

Author: Ike Q Sikakana[1]

Co-author: Tukisho A Masha [1]

[1] *Department of NDT and Physics, Vaal University of Technology*

Corresponding Author: ike@vut.ac.za

A compressional piezoelectric transducer of frequency 4 MHz mounted on machined perspex wedges, placed on carbon steel was studied. At a defined incident angle, compression waves are mode converted to shear waves at the interface between perspex and carbon steel. Increasing the incident angles, that is, using larger angle perspex wedges, two refraction critical angles are observed according to Snell's law, first corresponding to compression waves and second to shear waves. Our results - both experimental and Matlab calculations - show that for perspex wedges with geometric angles of 70 degree; surface waves are produced in carbon steel. A plot of the acoustic wave maximum value reflection intensities against the angles of incidence confirms established behaviour. the propagation and interaction of surface waves in a 3-notch 4340 steel calibration block is further analysed.

This simple instrumentation configuration is shown to be effective in the characterisation of surface breaking flaws in steel.

Physics of Condensed Matter and Materials 1 / 16

Mechanical milling effect on the structural and magnetic properties of sintered La_{0.67}Sr_{0.33}MnO₃

Author: Itegbeyogene Ezekiel[1]

Co-author: Thomas Moyo [1]

[1] *University of KwaZulu-Natal*

Corresponding Author: itegbeyogene@gmail.com

Structural and magnetic properties of sintered and milled La_{0.67}Sr_{0.33}MnO₃ was investigated in the temperature range of 300-2 K. The refined X-ray diffraction (XRD) data show that all samples are single phase and crystallize in rhombohedral symmetry with <i>R-3C</i> space group. The as-prepared samples (SK) where milled for 1, 3, 6 and 12 hours (SKM1, SKM3, SKM6 and SKM12). The crystallite size decreased from 46-11 nm as a function of milling except for SKM12 which increased slightly to 12 nm due to thermal effect of prolonged milling. The cell volume increased from 349-352 Å³ except for SKM12 which dropped to 349 Å³ due to peak shift to a higher 2<i>θ</i> as a result of strain. High-resolution transmission electron microscopy HRTEM and high-resolution scanning electron microscopy HRSEM of the samples show a variation in the morphology. The saturation magnetisation <i>M_S</i> was estimated from the hysteresis loops using the law of approach to saturation magnetisation. <i>M_S</i> for all samples increases as temperature decreases. At the maximum and minimum measuring temperature of 300 K and 2 K respectively, the <i>M_S</i> for SK, SKM1, SKM3, SKM6 SKM12, are 52, 45, 22, 13, 7 emu/g and 80, 79, 64, 53, 40 emu/g respectively. The drop in <i>M_S</i> has been explored based on a core-shell model. The coercivity at 2 K showed a significant increase from 0.17 kOe for SK to 0.87 kOe for SKM12. The hysteresis loops of all samples at 2 K exhibit a trend from superparamagnetism to ferromagnetism, while at 300 K, a trend of superparamagnetism to paramagnetism is observed.

Summary:

Mechanical milling, superparamagnetism, paramagnetism, ferromagnetism

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Dr. Thomas Moyo, moyo@ukzn.ac.za
University of KwaZulu-Natal
Westville Campus, Durban, South Africa

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 81 / **17**

First year university physics students' understanding of units and measurements

Authors: Leelakrishna Reddy[1]; Sam Ramaila[1]

[1] *University of Johannesburg*

Corresponding Author: samr@uj.ac.za

Adequate understanding of units and measurements is a key competence required for the enhancement of scientific literacy. Success in both theoretical and practical components of Physics courses depends to a large extent on the ability to convert and manipulate both fundamental and derived units. In light of this imperative, this investigation probed students' conceptual competence in units and measurements as crucial aspects associated with both theory and practical work in Physics. The sample in this research comprised students enrolled for diploma programmes in the Faculties of Engineering and Health Sciences at the University of Johannesburg. Key findings in this research strongly suggest that students' conceptual competence in units and measurements appears to be a function of the intrinsic requirements of the respective academic programmes.

Poster Session 2 - Board: 82 / **18**

First year university physics students' perceptions of instructional methods

Authors: Leelakrishna Reddy[1]; Sam Ramaila[1]

[1] *University of Johannesburg*

Corresponding Author: samr@uj.ac.za

Students' academic experiences can be maximized through meaningful pedagogic tasks that are central to the improvement of instruction in various educational settings. The effectiveness of various teaching methods remains a key imperative for the realization of meaningful student academic performance. As part of this inquiry, Physics students' perceptions of various teaching methods were uncovered through the administration of a survey questionnaire after which interviews were conducted to corroborate the views expressed. Responses to the questionnaire appeared to gravitate towards the lecture method and group discussion as preferred instructional methods. Implications for the improvement of instruction are discussed.

Poster Session 2 - Board: 83 / **19**

Assessment of physics practicals using a technology-aided system

Authors: Leelakrishna Reddy[1]; Sam Ramaila[1]

[1] *University of Johannesburg*

Corresponding Author: samr@uj.ac.za

Traditionally evaluation of physics practical work at universities is based on a laboratory report characterising the activities a particular experiment. Such an evaluation generally puts a learner under considerable pressure in view of the required language proficiency as an additional aspect considered during the evaluation of the report and for which penalties might be incurred. This article provides a description of a technology-aided system utilized for assessment of physics practicals which does not require language proficiency. The experimental reports assessed through the system are characterised by key features such as figures, graphs and drawings. The underlying theoretical

knowledge associated with the experiment is provided as part of a detailed experimental procedure. The technology-aided system provided the capacity needed for handling large volumes of practicals in view of the high number of students performing practical work in the physics laboratories at a South African university over the years. In addition, the system also makes provision for a large number of experiments to be carried out and assessed in a sustainable manner.

Poster Session 2 - Board: 84 / **20**

Soweto Science Centre as a flagship community engagement initiative

Authors: Leelakrishna Reddy[1]; Sam Ramaila[1]

[1] *University of Johannesburg*

Corresponding Author: samr@uj.ac.za

A flagship community engagement initiative is coordinated within the Faculty of Science at a South African university. This initiative takes the form of a strategic and innovative instructional intervention which makes provision for tutoring of learners in the Further Education and Training (FET) band by providing tuition through contact sessions on Fridays, Saturdays and during school recess. Learners are drawn from schools located within Soweto Township and the surrounding areas. Prior to the commencement of the mentoring intervention, learners' pre-entry characteristics in terms of the conceptual competence in various Physical Science knowledge areas covered at school were established through carefully structured knowledge, synthesis and application-type questions which formed an integral part of a diagnostic conceptual assessment instrument. In particular, the findings of this research revealed inadequacies in relation to the Physics content covered at schools as well as the competency of the FET teachers in the Physics conceptual knowledge areas investigated. Key findings that emerged from this investigation appear to be commensurate with documented research studies on Physical Science teachers' content knowledge and pedagogical content knowledge within the broader South African educational context. Implications for the coherent infusion of strategic and innovative instructional interventions in various educational settings are discussed.

Poster Session 2 - Board: 37 / **21**

INVESTIGATING DIFFUSION OF XENON IMPLANTED GLASSY CARBON

Author: Mahjoub Ismail[1]

Co-authors: Johan Malherbe [2]; Thulani Hlatshwayo [2]

[1] *Postgradiuate student*

[2] *UP staff*

Corresponding Author: mmahjoub2010@gmail.com

Recently, there has been a renewed interest in employing glassy carbonto contain radioactive fission products. Oneof the fission products, Xe is significant by itself due to its high neutron absorption crosssection and high production as a fission product. 200 keV Xenon (Xe) ions were implanted in the glassy carbon samples to a fluence of 1 × 10ˆ16 Xe+ cm-2 at room temperature. The diffusion of the implanted Xenon in the glassy carbon was measured using Rutherford backscattering (RBS) after vacuum annealing. The surface topography of the samples before and after each annealing temperature was investigated using scanning electron microscopy (SEM).

**Apply to be
 considered for a student
   award (Yes / No)?:**

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Johan Malherbe
Johan.Malherbe@up.ac.za
University of Pretoria

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 44 / **22**

SHI irradiation enhanced diffusion of silver implanted into polycrystalline SiC

Author: Hesham Abdelbagi Ali Abdelbagi[1]

Co-authors: Johan Malherbe [1]; Thulani Hlatshwayo [1]

[1] *University of Pretoria*

Corresponding Author: heshamabdelbagi100@gmail.com

Migration behavior of silver (Ag) ions implanted into polycrystalline CVD-SiC was investigated by Rutherford backscattering spectrometry (RBS), Raman spectroscopy and scanning electron microscopy. Silver ions of 360 keV were implanted into CVD-SiC to a fluence of 2×1016 cm-2 at room temperature. Some of implanted samples were irradiated with xenon (Xe) ions of 167 MeV to a fluence of 3.4×1014 cm-2 and 8.4×1014 cm-2 at room temperature. Both the as-implanted and implanted then irradiated samples were isochronal annealed at temperatures ranging from 1100 oC to 1400 oC in steps of 100 oC for 10 h. Raman results of the as-implanted samples showed that implantation of Ag resulted in the amorphisation of SiC, while irradiation of the as-implanted samples with Xe ions caused some recrystallization. Recrystallization was already taking place after annealing at 1100 oC in both samples. After annealing at 1400 oC, un-irradiated samples were fully recrystallized, while the irradiated samples were still not fully recrystallized. Ag started to move towards the surface without broadening after annealing at 1100 oC in the un-irradiated samples, while no movement of Ag was detected in the irradiated samples up 1200 oC. Diffusion of Ag was detected after annealing at 1300 oC for the irradiated samples and no diffusion was detected in the un-irradiated samples up to 1400 oC. Therefore, SHI irradiation somehow enhanced diffusion of Ag.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Nuclear, Particle and Radiation Physics 1 / **23**

Assessing the impact of phosphate rock storage on uranium and thorium concentration in soil samples from Richards Ray using Neutron Activation Analysis.

Author: FEILIX MASOK[1]

Co-authors: Dazmen Mavunda [2]; Hartmut Winkler [3]; Paulus Masiteng [1]; Peane Maleka [4]

[1] *University of Johannesburg*

[2] *Necsa/UJ*

[3] *Dept. Physics, University of Johannesburg*

[4] *iThemba LABS*

Corresponding Author: masokfelix@gmail.com

Uranium-238 (U-238) and thorium-232 (Th-232) are the parent primordial nuclides who along with their progenies are sources of radiation exposure to which humans are exposed directly or indirectly. U-238 decay to Pb-206 after 14 different alpha or beta decays, while Th-232 decay series terminate at Pb-208 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 using a gas flow proportionality counter to estimate the total activity of each sample without regards to specific nuclides. The samples were further analyzed for U-238 and Th-232 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). 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 U-238 and Th-232 concentration was established. Furthermore, specific activities of U-238 and Th-232 in a reference phosphate rock samples were analyzed and obtained to be 118 Bq.kg-1 and 783 Bqkg-1 respectively. These activity concentrations of these primordial radionuclides (238U and 232Th) in the analysed samples were found to be below the limits set out by International Council on Radiation Protection (ICRP).

**Apply to be
 considered for a student
   award (Yes / No)?:**

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

PhD

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Physics of Condensed Matter and Materials 1 / 24

Using the Barkhausen Effect to Measure the Microstructure of Ferromagnetic Materials

Author: Volkmar Nolting[1]

[1] *Vaal University of Technology*

Corresponding Author: volkmarn@vut.ac.za

The magnetization M(T,B) of a ferromagnetic material as calculated from standard models of magnetism makes a couple of theoretical assumptions that are not fulfilled in a real lattice. One consequence of this is the Barkhausen effect which experimentally verifies the existence of ferromagnetic

domains. From the energy of the domain wall its thickness, the energy per unit area, the restoring force, and the coercitivity are calculated and compared with experimental data. Magnetization curves M(H) are plotted for both the easy and the hard axis of anisotropic materials. Magnetic anisotropy furthermore affects the domain structure of a ferromagnetic material. It is shown that magnetoacoustic emission and magnetostriction data are only correlated in the case of isotropic materials. In general such a correlation does not exist.

Summary:

The magnetization curve M(H) as calculated from the Heisenberg model is only a correct description for the first magnetization stage of the hysteresis loop. When a magnetic field is applied the size of the domain changes. This domain wall motion is in general irreversible as domain walls are preferably located at impurities and lattice defects that restrict their motion. Magnetoacoustic emission data are potentially useful for detecting microstructural features in magnetic materials. Electromagnetic techniques in non-destructive evaluation have a special role to play here as both electromagnetic and mechanical properties are influenced by the same microstructural parameters and the way they change during material processing and degradation.

Poster Session 1 - Board: 74 / **25**

Three party reference frame independent quantum key distribution protocol using GHZ states

Author: Comfort Sekga[1]

Co-author: Mhlambululi Mafu [2]

[1] *Department of Physics and Astronomy, Botswana International University fo Science and Technology, Private Bag 16 Palapye, Botswana*

[2] *Botswana International University of Science and Technology*

Corresponding Author: comfort.sekga@studentmail.biust.ac.bw

Quantum key distribution (QKD) can be used to securely exchange the secret key between the communicating parties which are conventionally referred to as Alice and Bob. The protocol exploit the laws of quantum mechanics to detect any eavesdropper who tries to gain the knowledge of the key. For most existing QKD protocols, it is essential to have a known reference frame between the communicating parties. For instance, alignment of polarisation states for polarizing encoding and interferometric stability for phase coding. However, unstable fibre communication links or imperfections in the measuring devices may lead to unknown and varying reference frame and has detrimental effects on the states received by Bob. Efforts has been made to tackle potential reference frame misalignment by encoding qubits with larger systems. However, this requires creation and manipulation of many photon entangled states which are very difficult to generate and are very sensitive to losses. Therefore, we present a three party reference frame independent QKD protocol, which can be implemented without any alignment between the sender and the receiver. In our protocol the key is extracted from the measurement of the GHZ states initially shared between the communicating parties. We prove the security of the protocol against collective attacks under one way classical post-processing. Our results shows that the protocol is very robust against these attacks as we obtained an error rate threshold of 18.5%.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Space Science / **26**

The Solar Dynamics Observatory eclipse season is not consistent with what is to be expected from an eclipse

Author: Claudia Albers[1]

[1] *WITS university*

Corresponding Author: claudia.albers@wits.ac.za

The Solar Dynamics Observatory is a geosynchronous satellite with an orbital tilt, with detectors aimed at the Sun. It provides images of the Sun in various wavelengths, from x-ray to visible light. The satellite is supposed to see the Sun being eclipsed by the Earth for about an hour a day, for 24 days, twice a year. However, examination of the images it detects, since 2011, at the beginning of each eclipse season, reveals that different percentages of the Sun are visible at different wavelengths, in images with the same time stamp. In addition, the Sun's corona in the 19.3 and 21.1 nm wavelengths shrinks, as the less of the Sun is visible in the images. This is not consistent with what is to be expected from an eclipse.

Astrophysics / **27**

Brown Dwarfs and Brown Dwarf stars: what is the difference and the observational evidence for the existence and presence of both in the Solar System

Author: Claudia Albers[1]

[1] *WITS university*

Corresponding Author: claudia.albers@wits.ac.za

Brown Dwarfs are sub-stellar objects, somewhat between gas giant planets and small stars. Brown Dwarf Stars are the remains of a main sequence star that has gone through the white dwarf stage after releasing its outer layers of gas. These stars are therefore surrounded by clouds of ionised gas. The Brown Dwarf Star stage is reached when the core of the once main sequence star, no longer emits large amounts of visible light and may only emit infrared radiation. In this paper, I provide observational evidence for the existence and presence of both types of objects inside the Solar System.

Physics of Condensed Matter and Materials 1 / **28**

Computational modelling study on elastic properties and temperature variation in Ti₅₀Pt_{50-x}Cu_x shape memory alloys

Author: Rosinah Modiba[1]

Co-author: Phuti Ngoepe [2]

[1] *CSIR*

[2] *University of Limpopo*

Corresponding Author: rmahlangu1@csir.co.za

Recently, there is a high demand of shape memory alloys that can be used at high temperatures. TiPt is found to be one of the promising alloys with the transformation temperature of 1300 K. Previous studies showed that the alloy is mechanically unstable with the negative C' modulus at 0 K. In order to enhance the mechanical properties of the alloy, a third element Cu was substituted in the TiPt. The stability of the structures with respect to their equilibrium lattice parameters and heats of formation were determined. It was found that increasing Cu content stabilizes the TiPt with a positive C' observed for 12.25 at.% Cu. Furthermore, we investigated the temperature dependence of the lattice parameters and Copper is found to be lowering the martensitic transformation temperature of the TiPt shape memory alloy.

**Apply to be
 considered for a student
   award (Yes / No)?**:

no

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

n/a

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

no

Astrophysics / **29**

The Madala Hypothesis and Indirect Dark Matter Detection

Authors: Geoff Beck[1]; Sergio Colafrancesco[2]

[1] *University of Witwatersrand*

[2] *University of the Witwatersrand*

Corresponding Author: geoff.m.beck@gmail.com

The Madala hypothesis, invoked by South African scientists (von Buddenbrock et al 2015 & 2016), extends the standard model to cover anomalies in the transverse momentum of the Higgs boson (among other anomalous excesses) seen at the Large Hadron Collider. As the evidence continues to hint in favour of this scenario it is worthwhile to explore its cosmological and astrophysical consequences. These arise as the effective field theory used includes a dark matter candidate whose Standard Model interactions are mediated by an additional scalar boson S.
In this work we will study the limits on the decay branching of the boson S following dark matter annihilation using data from the Coma galaxy cluster and Reticulum II dwarf galaxy. In so doing we will see that couplings of the S boson cannot be Higgs-like, contrary to what was originally assumed in the hypothesis for simplicity. This results in new constraints on the hypothesis independent of collider data.
We will also explore to what extent the Madala dark matter can explain the gamma-ray excess observed in the galactic centre, as well as other gamma-ray excesses claimed towards dwarf galaxies.

Summary:

We examine the consequences of indirect dark matter searches on the recent Madala hypothesis (von Buddenbrock et al 2015 & 2016), designed to explain anomalies in LHC Higgs boson data by introducing several additional scalar particles. We do this in the Coma galaxy cluster as well as the Reticulum II dwarf galaxy, using both radio and gamma-ray data, to derive new constraints on the model independent of existing collider data.

Astrophysics / 30

The Cosmology of Gravitational Scalar-Tensor Theories

Author: Heba Abdulrahman[1]

[1] *North West University, South Africa*

Corresponding Author: heba@aims.edu.gh

Recent developments in observational cosmology and astronomy (such as
the apparent discovery of the accelerated expansion of the Universe and the
existence of dark matter) have put theoretical physics in general and cosmology in particular into crisis. In this thesis, we introduce a detailed review of Einstein's theory of general relativity by which standard cosmology based on.
We present the challenges to Einstein theory of gravity and the difficulties of the current theoretical cosmology in explaining the accelerated expansion of the
Universe. Although General Relativity Theory (GR) is a generalization of Newtonian Gravity in the presence of strong gravitational fields, there is no properly defined Newtonian limit of (GR) on cosmological scales. Recently, general relativistic quasi-Newtonian cosmologies have been studied in the context of large scale structure formation and nonlinear gravitational collapse in the late-time Universe. This despite the general covariant inconsistency of these cosmological models except in some special cases such as the spatially homogeneous and isotropic, spherically symmetric, expanding (FLRW) spacetimes. Higher-order
gravitational theories, such as f (R) models, have been shown to exhibit more shared properties with Newtonian gravitation than does GR. In this work, we study the existence and integrability conditions of quasi-Newtonian cosmological spacetimes in Scalar-Tensor theories of gravitation. We will also derive the
covariant density and velocity perturbations of such models and analyze the corresponding solutions.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Msc

**Main supervisor (name and email)
and his / her institution**:

Dr.Amare Abebe
amare.abbebe@gmail.com
North West University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

no

Astrophysics / 31

Spectral analysis of Fermi-LAT Gamma-ray bursts with known redshift and their potential use as cosmological standard candles

Author: Feraol F. Dirirsa[1]

Co-authors: Frédéric Piron [2]; Soebur Razzaque [1]

[1] *University of Johannesburg*

[2] *Université de Montpellier*

Corresponding Author: fdirirsa@uj.ac.za

Long duration Gamma-Ray Bursts (GRBs) may serve as new standard candles to constrain cosmological parameters by probing the Hubble diagram well beyond the range of redshift currently accessible using type-Ia supernovae. The standardization of GRBs is based on relations which correlate two or more parameters, found from gamma-ray spectral modelling of which one is strongly dependent on the cosmological model. Amati et al. (2002) relation in particular is between the source rest frame energy (Ei,p) at which the prompt gamma-ray spectral energy distribution peaks and the isotropic-equivalent bolometric energy (Eiso). We built a sample of 25 long GRBs (LGRBs) with known redshift, which have been detected by the Fermi GBM and LAT instruments in eight years of operations (2008 - 2016). We derive Ei,p and Eiso for these LGRBs using the GBM and LAT data in joint spectral fits, often requiring multiple components, thus extending the computation of Eiso to the GeV range. Our results show that LGRBs detected by Fermi-LAT with significant GeV emission are consistent with the Amati relation and further enhance the possible use of GRBs as cosmological standard candles.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. Soebur Razzaque
University of Johannesburg

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 75 / **32**

Security proof of a generic three party Quantum Key Distribution protocol

Author: Comfort Sekga[1]

Co-author: Mhlambululi Mafu [2]

[1] *Department of Physics and Astronomy, Botswana International University fo Science and Technology, Private Bag 16 Palapye, Botswana*

[2] *Botswana International University of Science and Technology*

Corresponding Author: comfort.sekga@studentmail.biust.ac.bw

Quantum cryptography or more specifically Quantum key distribution (QKD) is the emerging technology that has shown to be provably secure for transmitting messages between the communicating parties. The security of a QKD protocol is mainly based on the laws of quantum mechanics. In this work, we present a simple security proof for a three party generic QKD protocol. The protocol is implemented using the GHZ states and each party has to perform a single particle measurement either on the computational basis or the Hadamard basis. The security analysis of our protocol is based on the collective attacks and we used one way information reconciliation and privacy amplification to extract the key. Eve's information is conditioned on the random variable V, which provide all the projective measurements on the density operator ρ_ABC. The value obtained for the error bound is $\epsilon \approx 0.031$.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Poster Session 1 - Board: 02 / **33**

Deposition time effect on the structural, optical and morphological properties of chemically synthesized PbS thin films

Author: Fekadu Gashaw Hone[1]

Co-author: Frances Birhanu Dejene [1]

[1] *University of the Free State*

Corresponding Author: fekeye@gmail.com

Lead sulphide thin films were deposited on glass substrates by facial chemical bath deposition method at a pH of 13 and cationic concentration 0.2 M. Four samples were prepared by employing different deposition times and the deposited thin films were uniform, well adherent and grey in color. Energy dispersive X-ray spectroscopy, Scanning electron microscopy, X-ray diffraction, Spectrophotometer were used to study the effect of deposition time on the physical and chemical properties of PbS thin films. The X-ray diffraction analysis revealed that the deposited PbS thin films were polycrystalline in nature and the grains were grown along the (111) plane. The grain sizes calculated from FWHM were found to increase where as the strain and dislocation density were found to decrease as deposition time increased from 20 to 50 min. The elemental compositions study reviled that no significant change was observed on the stoichiometric nature of the material due to variation of deposition time. The SEM micrograph observation reviled that the thin films cover the substrate without any crake and voids. The optical study showed that the optical band gap of PbS thin films decreased almost linearly while deposition time increased.

Key words: Lead sulphide, Grain sizes, Chemical bath deposition and Polycrystalline

Theoretical and Computational Physics 1 / **34**

Driven non-equilibrium systems modeled with Markov processes

Author: Pelerine Tsobgni Pelerine[1]

Co-author: Hugo Touchette [2]

[1] *University of Stellenbosch*

[2] *National Institute for Theoretical Physics, University of Stellenbosch*

Corresponding Author: tsobgnipelerine@gmail.com

I will present in this talk my research on how fluctuations arise in nonequilibrium systems modeled by Markov processes and how to construct effective dynamics associated with these fluctuations.

To discuss this, I will present two simple stochastic models:

• A particle on a ring, evolving with a driving force and the potential under the influence of a stochastic force. For this model I will look at the current fluctuations observable.

• A stock market, modeled as geometric Brownian motion, where I will study the fluctuations of the occupation, corresponding to prices fluctuation.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

htouchette@sun.ac.za

National Institute for Theoretical Physics (NITheP)

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Nuclear, Particle and Radiation Physics 1 / 35

Photon strength function studies at iThemba LABS – latest developments

Author: Mathis Wiedeking[1]

[1] *iThemba LABS*

Corresponding Author: wiedeking@tlabs.ac.za

An incredible wealth of information can be obtained from investigations of the low-energy tail of the Giant Electric Dipole Resonance. The Photon Strength Function (PSF), which represents the ability of nuclear matter to absorb and emit photons, is one of the quantities that is used successfully to extract resonance features in the region of the quasi-continuum. The PSF is one of the input parameters for calculations of nuclear cross sections and reaction rates relevant to astrophysical processes which are invoked to explain the origin of elements heavier than iron.
In this talk I will focus on the experimental work to study the gamma-ray decay from the region of high-level density at iThemba LABS. In particular I will discuss the latest developments which include the world's first measurement using inverse kinematic reactions to study the PSF, as well as the significant enhancement of our experimental capabilities which will lay the foundation for future high-impact measurements.

Space Science / 36

Ensemble Estimation of Network Parameters: A Tool to Improve the Real-time Estimation of GICs in the South African Power Network

Author: Michael Heyns[1]

Co-authors: Pierre Cilliers [2]; Stefan Lotz [3]; Trevor Gaunt [4]

[1] *UCT/SANSA*

[2] *SANSA Space Science*

[3] *SANSA*

[4] *UCT*

Corresponding Author: mheyns@sansa.org.za

Large grounded conducting networks on the surface of Earth, such as power lines or pipelines, have long been known to be affected by solar activity and subsequent geomagnetic storms. With the increased use of electrical technologies, society has become more and more dependent on electrical power and power networks. These power networks form extensive grounded conductors which are susceptible to geomagnetically induced currents (GICs).
GICs at any specific node in a power network are assumed to be linearly related to the horizontal vector components of an induced plane-wave geoelectric field by a pair of network parameters. The network parameters are not easily measured in the network, but may be estimated empirically. In this work, we present a new approach of using an ensemble of network parameters estimates. The ensembles include a huge number of parameter pair estimates calculated from simultaneously solving pairs of time instances of the governing GIC equation. Each individual estimate is not the true state of the system, but a possible state. Taking the ensemble as a whole though gives the most probable parameter estimate. The most probable parameter estimate for both network parameters, as defined by their respective ensembles, is used directly in the modelling of GICs. The ensembles themselves however allow for further analysis into the nature of GICs.
An improvement is seen when comparing the out-of-sample performance of the ensemble estimates with previous GIC modelling in the South African power network during the Halloween Storm of 2003. For the first time, it is shown that errors in the GIC modelling chain are absorbed into the network parameter estimates. Using a range of estimates from the ensemble, a GIC prediction band is produced. This band corresponds to an error estimate for predicted GIC. Furthermore, it has been explicitly shown for the first time that estimated network parameters vary with GIC magnitude during an event. This behaviour is then used to refine the parameter estimation further and allow for real time dynamic network parameter estimation.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof. C. T. Gaunt (ct.gaunt@uct.ac.za)
University of Cape Town

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Theoretical and Computational Physics 1 / 37

Evolution of the Yukawa couplings in 5-dimensions for an SU(3) gauge group

Author: Alan Cornell[1]

Co-author: Mohammed Omer Khojali [2]

[1] *NITheP*

[2] *Sudanese*

We explicitly test, in a simplified 5-dimensional model with an SU(3) gauge symmetry, the evolution of the Yukawa couplings. We assume that all the matter fields are propagating in the bulk, and consider orbifolds based on Abelian discrete groups which lead to 5-dimensional gauge theories compactified on an S1/Z2 . The Yukawa couplings evolution is derived at one-loop level and used to test the impact on lower energy observables.

Astrophysics / 38

Multi-TeV flaring from blazars: Markarian 421 as a case study

Author: Sarira Sahu[1]

Co-author: Luis Salvador Miranda Palacios [2]

[1] *Universidad Nacional Autónoma de México*

[2] *University of Johannesburg*

Corresponding Author: chavahell9@gmail.com

The TeV blazar Markarian 421 underwent multi- TeV flaring during April 2004 and simultaneously obser- vations in the X-ray and TeV energies were made. It was observed that the TeV outbursts had no counterparts in the lower energy range. One implication of this is that it might be an orphan flare. We show that Fermi-accelerated protons of energy ≤168 TeV can interact with the low energy tail of the background synchrotron self-Compton photons in the inner region of the blazar to produce the multi-TeV flare and our results fit very well with the observed spectrum. Based on our study, we predict that the blazars with a deep valley in between the end of the synchrotron spectrum and the begin- ning of the SSC spectrum are possible candidates for orphan flaring. Future possible candidates for this scenario are the HBLs Mrk 501 and PG 1553 + 113 objects.

Nuclear, Particle and Radiation Physics 1 / 39

Towards implementation/development of the state-of- the-art electron spectrometer capability at iThemba LABS

Author: Abraham Avaa[1]

Co-authors: Bonginkosi Zikhali [2]; Garrett de Villiers [2]; Iyabo Usman [3]; John Carter [3]; Pete Jones [2]; Tibor Kibedi [4]

[1] *Wits/iThemba*

[2] *iThemba*

[3] *Wits*

[4] *ANU*

Corresponding Author: abi@tlabs.ac.za

An electron spectrometer that implement a Si(Li) detector for the detection of internal conversion electrons and a combination of LaBr3 detectors for the detection of coincident decays is undergoing development at iThemba LABS, South Africa. For optimization of measurements with the electron spectrometer, electron calibration sources (207Bi and 133Ba) are used in the measurements of energy and momentum resolution of the Si(Li) detectors. Other parameters such as transmission and efficiency which are used in describing the performance of electron spectrometer, are also determined during the characterization measurements. Lifetime measurements which provide crucial information needed for the measurement of E0 matrix elements will be performed using LaBr3 detectors. Electron energy versus magnet current calibration was done by varying the lens current repeatedly

to ensure reproducibility. Characterization measurements are presented and discussed for the purpose of commissioning the electron spectrometer for the study of 0+ states at iThemba LABS.
Keywords: Electron spectrometer, internal conversion electrons, coincident decays, electron energy, magnetic current.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Dr. Usman Iyabo
University of the Witwatersrand, Johannesburg.
Iyabo.Usman@wits.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 03 / **40**

The role of Zn2+ ion on the optical properties of novel Ba1-xZnxZrO3: Mn perovskite

Author: Iorkyaa Ahemen[1]

Co-author: F.B. Dejene [2]

[1] *University of The Free State Qwqwa Campus*

[2] *University of the Free State South Africa*

Corresponding Author: ahemior@gmail.com

This work presents the effect of Zn2+ ion concentration on the optical properties of a newly formulated perovskite with or without a dopant. The Ba1-xZnxZrO3 perovskite was synthesized using the solution combustion technique. The scanning electron micrographs show particles with irregular shapes which agglomerated into a dense structure. The sizes of the particles were in the range 30 to 75 nm. X-ray diffraction measurement gave pure cubic perovskite structure at all concentrations of the Zn ion. Photoluminescence excitation spectra show a slight red-shift of the excitation band due to the presence of Zn2+ ions. The doped perovskite show strong emission of Mn2+ ion at 585 nm and the intensity of this band increases with increasing concentration of Zn2+ ion. The possible reason for this enhancement of emission intensity of Mn2+ ion is the substitution of the ion at Zn2+ ion's site due to the similarity of their ionic radii. The International Commission on Illumination (CIE) coordinates confirm the orange-light emission of the doped perovskite. The Ba1-xZnxZrO3 host can be effectively applied in solar cells, photocatalysis and as a host matrix for efficient phosphors. The Ba1-xZnxZrO3: Mn perovskite is therefore is a good orange-coloured light emitter which can be effectively excited by a near UV source such as LED.

Summary:

perovskite, orange light, combustion synthesis, photoluminescence, optical properties

Poster Session 1 - Board: 04 / **41**

Effect of Deposition Temperature on the Structural, Morphological and Electrochemical Properties of LiFePO4 Thin films Nanomaterials Prepared by Chemical Bath Deposition.

Authors: DONALD DEHIIN HILE[1]; LEHLOHONOLO FORTUNE KOAO[1]

Co-authors: IORKYAA AHEMEN [1]; KOMAHELO GEORGE TSABALALA [2]; SETUMO VICTOR MOTLOUNG [3]

[1] *UNIVERSITY OF THE FREE STATE, QWAQWA CAMPUS*

[2] *UNIVERSITY OF THE FREE STATE, QWAQWA, CAMPUS*

[3] *SEFAKO MAKGATHO HEALTH SCIENCE UNIVERSITY, MEDUNSA*

Corresponding Author: donald.hile@gmail.com

The advantages of LiFePO4 nanomaterials for use as positive electrode in lithium ion batteries are their excellent cycle life, structural stability, cost effectiveness and environmental friendliness. Their main limitation however is the low electrical conductivity which can be overcome by synthesizing particles at the nanoscale with homogenous size distribution. This work employs a simple and cost effective method to produce homogenous nanoparticles of lithium iron Phosphate (LiFePO4). The nanoparticles were deposited on Fluorine doped Tin Oxide (FTO) glass substrates at temperatures of 25, 60, 70, 80, 90, and 100 oC using chemical bath deposition (CBD) method. The surface structure, morphology and electrochemical analyses were carried out on the deposited films, studied and reported. The morphology of the deposited films was studied using scanning electron microscopy (SEM) and the films exhibited homogeneous average crystal sizes. X-ray diffractometry (XRD) studies revealed highly polycrystalized structures, which increased with deposition temperature. The crystal grain sizes were calculated from the XRD results using Crystallite Size and D.K. Shukla Crystal Size Calculation software. The average crystal sizes of the deposited films were found increasing from 121-153nm with increased deposition temperature. The charge-discharge test was carried out using cyclic voltammetry and it showed an increased specific charge capacity up to 153mAhg-1 with increased temperature of deposition. The work concluded that deposition temperature has great influence on the morphology and electrochemical properties of the thin films.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Dr Koao Lehlohonolo Fortune.
E-mail: koaolf@ufs.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 45 / **42**

Microwave-assisted synthesis of cobalt sulphide nanoparticles clusters on activated graphene foam for electrochemical supercapacitor

Author: Tshifhiwa Moureen Masikhwa[1]

Co-authors: Abdulhakeem Bello [1]; Joel Lekitima [1]; Moshawe Jack Madito [1]; Ncholu Manyala [1]

[1] *University of Pretoria*

Corresponding Author: moureenmasikhwa@gmail.com

Cobalt sulphide (Co9S8) nanoparticles clusters embedded in activated graphene foam (AGF) structure were prepared using microwave-assisted hydrothermal synthesis. Morphological characterization of as-prepared Co9S8/AGF showed that Co9S8 composed of cluster (sphere)-like nanoparticles embedded in the matrix of a porous sheet-like AGF. The synergy between the Co9S8 nanoparticles and AGF in the Co9S8/AGF composite showed predominantly an improvement in the porous nature (surface area and pore volume) of the Co9S8 and the electrical conductivity of the composite electrode. The composite exhibited a specific capacitance of 1150 F g-1 as compared to Co9S8 with specific capacitance of 507 F g-1 at a scan rate of 5 mV s-1 and good cycling stability in 6 M KOH electrolyte. Co9S8/AGF composite showed significant improvement on the specific capacitance compared to pure Co9S8 and specific capacitance values found in previously published reports by other studies for cobalt sulphide-based composites.

Summary:

Cobalt sulphide (Co9S8) nanoparticles clusters embedded in activated graphene foam (AGF) structure were prepared using microwave-assisted hydrothermal synthesis. Morphological characterization of as-prepared Co9S8/AGF showed that Co9S8 composed of cluster (sphere)-like nanoparticles embedded in the matrix of a porous sheet-like AGF. The synergy between the Co9S8 nanoparticles and AGF in the Co9S8/AGF composite showed predominantly an improvement in the porous nature (surface area and pore volume) of the Co9S8 and the electrical conductivity of the composite electrode. The composite exhibited a specific capacitance of 1150 F g-1 as compared to Co9S8 with specific capacitance of 507 F g-1 at a scan rate of 5 mV s-1 and good cycling stability in 6 M KOH electrolyte. Co9S8/AGF composite showed significant improvement on the specific capacitance compared to pure Co9S8 and specific capacitance values found in previously published reports by other studies for cobalt sulphide-based composites.

Poster Session 1 - Board: 05 / **43**

Synthesis and characterization of LiMn2O4 nanostructures prepared by modified chemical bath method

Author: Lehlohonolo Koao[1]

Co-authors: Mesfin Kebede [2]; Setumo Motloung [3]; Thebe Mohapi [4]; Tshwafo Motaung [5]

[1] *UFS (Qwa Qwa)*

[2] *Council for Scientific and Industrial Research*

[3] *SMU*

[4] *Vaal University of Technology*

[5] *Unizulu*

LiMn2O4 powders were prepared by modified chemical bath method using citric acid (CA) a catalyst. The ratio of Li and Mn on LiMn2O4 was varied, respectively. The effect of molar ratio of Li and Mn on the thermal analysis, structure, morphology and optical properties of LiMn2O4 nanostructures were investigated, respectively. The thermogravimetric analyses (TGA) and differential scanning calorimeter (DSC) showed that the final yield decreases with an increase in the annealing temperature. The best thermal stability of LiMn2O4 nanopowders were obtained at Li:Mn:CA ratio of 2:1:10. The X-ray diffraction (XRD) results showed that the structure of spinel LiMn2O4 powders were obtained at molar ratio of 2:1:10 (Li:Mn:CA). Further increase in the molar ratio of Li and Mn respectively, there was formation of Mn2O3 structure. At low molar ratio of Li and Mn, respectively there was formation of spinel LiMn2O4 structure with the secondary phases. The estimated average grain sizes calculated using the XRD spectra were found to be in the order of 83 ± 1 nm for the LiMn2O4 powders prepared at molar ratio of 2:1:10 (Li:Mn:CA). The surface morphology study revealed the irregular nanoparticle. By varying the molar ratio of Li and Mn respectively, there was effect on morphology. The UV-Vis spectra showed that at low molar ratio of Li and Mn there are two broad peak at around 600 an 800 nm. Those peaks may be due to secondary phases because they disappear at single phase of spinel LiMn2O4 and Mn2O3 structures. Lithium ion batteries are widely used in portable equipment, such as mobile phone, notebook computer, electron instrument, and so on.

Poster Session 1 - Board: 06 / **44**

Hydrothermal Synthesis of NiO/graphene electrode and their application in CO sensing

Author: Abubakar Khaleed[1]

Co-authors: Abdulhakeem Bello [2]; Bonex Mwakikunga [3]; Faith Ugbo [1]; Kouadio Julien Dangbegnon [1]; Ncholu Manyala [1]

[1] *University of Pretoria*

[2] *Department of Physics University of Pretoria*

[3] *CSIR National Laser Centre*

Corresponding Author: abubakarkhaleed2@gmail.com

Monitoring trace concentrations of harmful gaseous chemical species are increasingly needed in different areas such as indoor, outdoor, vehicle air control, mining, and manufacturing sites. Hence, the fabrication of highly sensitive and selective chemical gas sensors are imperative. Chemi-resistive gas sensors based on semiconducting transition metal oxide are potential candidates due to their ease of operation, low cost of manufacturing, microscale miniaturization and good thermal and long-term stabilities [1–3]. In this work, spherical NiO/graphene foam (GF) composite with flowerlike structures was successfully synthesized for their application as CO reducing gas sensor via a hydrothermal reflux process. X-ray diffraction (XRD), scanning electron microscope (SEM), Fourier transforms infrared spectroscopy (FTIR) and gas sorption analysis was used to characterize the structure and morphology of the samples. The results obtained from the SEM micrographs showed that the flowerlike NiO spheres successfully coated the entire surface area of the GF. The performance of the composite towards CO gas sensing was studied. The results reveal that the incorporation of graphene into flowerlike NiO spheres not only improved the conductivity and surface area of NiO/GF composite but also enhanced the performance of the composite towards CO sensing. These results suggest that the composite could be a potential active material for CO reducing sensors.

References

[1] Gogotsi, Y., CRC Press, (2006).
[2] Huang, X.-J.; Choi, Y.-K., Sensors Actuators B Chem., 122 (2007), 659–671.
[3] Lu, J. G.; Chang, P.; Fan, Z., Mater. Sci. Eng. R Reports, 52 (2006), 49–91

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof Ncholu Manyala, ncholu.manyala@up.ac.za, University of Pretoria

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 46 / **45**

Activated carbon/Nickel-Aluminium double layer hydroxide composites for supercapacitor applications

Author: Belinda Moyo[1]

Co-authors: Abdulhakeem Bello [2]; Damilola Momodu [3]; Ncholu Manyala [1]

[1] *University of Pretoria*

[2] *Department of Physics University of Pretoria*

[3] *UNIVERSITY OF PRETORIA*

Corresponding Author: belinda.moyo@ymail.com

In this study, a detailed analysis of the electrochemical performance of activated carbon/Nickel-Aluminium layered double hydroxide (AC/NiAl-LDH) composites were investigated as potential electrode materials for electrochemical capacitors. The activated carbon (AC) was prepared via optimization of the carbonization temperature and activating agent (potassium hydroxide) from a tree-bark biomass raw material. Subsequently, porous NiAl-LDH was also obtained using a solvothermal technique by varying the syntheses times. The optimized activated carbon sample was then added to the NiAl-LDH sample in different masses to produce an AC/NiAl-LDH composite material. The morphology revealed an interconnected framework of both the AC and LDH structures. The specific surface area (SSA) of the AC/NiAl-LDH composite was seen to improve with an increase in the amount of AC added to the NiAl-LDH material. This increase in SSA enabled a better charge transfer propagation and charge storage within the composite when adopted as electrodes for supercapacitor. A specific capacity of 18.90 mAh/g was obtained for the AC/NiAl-LDH composite material. The results obtained demonstrate the potential of this composite material as electrodes for energy storage devices.

**Apply to be
 considered for a student
   award (Yes / No)?:**

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

Msc

**Main supervisor (name and email)
and his / her institution:**

Professor Ncholu Manyala
Ncholu.Manyala@up.ac.za
University of Pretoria

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Space Science / 46

Analysis of magnetotelluric data from the South African magnetotelluric network

Author: Electdom Matandirotya[1]

Co-author: Pierre J. Cilliers [2]

[1] *University of zimbabwe*

[2] *South African National Space Agency, Space Science Directorate*

Surface impedance data is required for estimating induced electric fields from measured geomagnetic data. Lack of surface impedance data was once cited as a limiting factor in modelling Geomagnetically Induced Currents in the Southern African region. For a very long period, the Southern African

region has relied on the magnetic field recorded from its four magnetic observatories, which are Tsumeb (TSU), Keetmanshoop (KMH) (in Namibia), Haretbeeshoek (HBK) and Hermanus (HER) (in South Africa). Since the year 2012 several magnetotelluric (MT) stations were deployed in South Africa and Namibia to add on to the magnetic field data acquisition network. The main aim was to have simultaneous co-located measurements of the magnetic and electric field so that the surface impedance can be derived. The current study presents the components of the surface impedance derived from the data from different MT stations using the full tensor method. A comparison of the electric field calculated using the derived surface impedance and the electric field measured at the site using the MT station for selected solar active days was done. From the derived surface impedance, the difference in the surface impedance of coastal and non-coastal region is observed. The high confidence obtained when the measured and calculated electric field are compared shows that the full tensor method is a tool that can be used to produce reliable surface impedance maps that can be used in enhancing the GIC modelling in South Africa and the region at large.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Prof. P. J. Cilliers
pjcilliers@sansa.org.za
SANSA Space Science

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Physics Education / **47**

Olympiads in the Digital Data Age

Author: Case Rijsdijk[1]

[1] *SAIP/ASSA*

Corresponding Author: particles@mweb.co.za

The focus of any Olympiad or Competition must be to identify local talent in various fields, and once done, it is necessary to develop a system of monitoring and supporting this talent. In this talk I will take a brief look at how SAPhO has managed this in the past and what needs to be done in the future. It is now possible to use on-line Olympiads and so increase the footprint of these Olympiads, and research is currently underway to evaluate these. It will also be possible to create and manage large databases to improve the analysis of results and method of monitoring successful students using these databases. I will also look at challenges in reaching targeted rural areas and the security of on-line STEMI Olympiads and Competitions.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

No

**Main supervisor (name and email)
and his / her institution**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 07 / **48**

Investigation of GeSn thin films using Real-Time and RBS channeling techniques at iThemba LABS

Author: Christopher Mtshali[1]

Co-authors: André Vantomme [2]; Carlos Pineda-Vargas [1]; Craig Comrie [1]; Phillip Sechogela [1]

[1] *iThemba LABS*

[2] *KU Leuven, Leuven, Belgium*

Corresponding Author: mtshali@tlabs.ac.za

Alloys of Group IV element, C, Si, Ge and Sn, have received significant interest in electronic industries due to unique and intriguing (Opto) electronic properties for these alloys as theory predicts. Significant alteration of the band structure causing indirect-to-direct transition of the band gap and increased mobility in the strained Ge thin film has been theoretically predicted for Ge alloyed with Sn triggering 13% lattice mismatch. Unfortunately the diamond structure of α-Sn is unstable above 13oC making it difficult to incorporate Sn in the Ge, and the Ge-Sn phase diagram predicts very little immiscibility, in fact limiting thermodynamically stable Sn incorporation to about 1%, which is too low to cause the desired properties. Despite these constraints careful preparation by MBE and CVD has enabled alloy levels of around 10% to be achieved.
Up until now much of the attention has gone into understanding the growth mechanism and properties of the as-grown strained GeSn films. Integration of these strained films into advanced electronic devices will also expose them to thermal treatments and to metallization, which may alter the stability of these metastable films. We have investigated the stability of Sn in GeSn thin films grown on Ge by using real-time RBS during a ramped thermal anneal to monitor their thermal stability during a thermal treatment. Real-time RBS has also been used to monitor the effect of metallization on the stability of Sn in the GeSn layer during their reaction with Ni and Co. RBS / channelling have also been used to establish if any relaxation occurs in the strained metastable films. According to the results the Sn in the GeSn film is stable up to at least 600oC. Reacting GeSn with Co reduces stability of Sn in the CoGeSn ternary formed and around 360oC the Sn atoms diffuse to the surface. Channelling measurements indicate that the GeSn strained layer relaxes during the thermal anneal.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Photonics / **49**

Taking Twisted Classical light for a Quantum Walk

Author: Bereneice Sephton[1]

Co-authors: Andrew Forbes [2]; Angela Dudley [3]

[1] *CSIR National Laser Centre; Wits Physics Department*

[2] *University of Witwatersrand; CSIR*

[3] *CSIR National Laser Centre*

Corresponding Author: bereneice21@gmail.com

Computational power available with classical computers has become increasingly limited for the scope required by many applications such as simulation and modelling in developmental research as well as factorization of large numbers. The solution for many of these problems lies in the development of quantum computers for which the physical implementation of quantum walks (QW) has been shown to provide a successful computational basis. Preforming such quantum walks is subsequently a promising route with derived algorithms already providing a comparative speedup to many of the classical alternatives. Substantial drive towards establishing a means of achieving QWs over the 20+ years since its introduction has occurred with entities such as ions, electrons and photons being utilized. Application of these walks on the quantum scale has not exceeded a few steps, however.

Here we consider exploitation of the 'classical entanglement' inherent in vector beams to perform such a physical implementation of quantum walks in orbital angular momentum space through polarization control. This method offers great advantages due to the robust nature of classical light manipulation as opposed to the vulnerability of quantum systems to environmental influence which limit the achievable length of the walk.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Professor Andrew Forbes
andrew.forbes@wits.ac.za
University of Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Photonics / **50**

Uncovering Orbital Angular Momentum with Mode Sorters

Author: Bereneice Sephton[1]

Co-authors: Andrew Forbes [2]; Angela Dudley [3]

[1] *CSIR National Laser Centre; Wits Physics Department*

[2] *University of Witwatersrand; CSIR*

[3] *CSIR National Laser Centre*

Corresponding Author: bereneice21@gmail.com

Orbital angular momentum (OAM) carrying beams are ubiquitous in many experiments being performed today and cover a wide range of research, from surface micro-structure processing to optical tweezers and communications. It follows that these beams are a significant factor in the outcome of

these research areas. Characterization of OAM beams lies in the ability to identify the OAM being carried. One such prominent method recently developed in 2010 by Berkhout <i>et al.</i> [1] is known as mode sorting whereby a geometric transformation is optically carried out on the beam. This converts OAM into transverse momentum, causing the beam to 'unravel' and allowing for the formation of spots with OAM-dependent positions through the Fourier transformation of a lens. We evaluate how the mode sorter achieves this transformation. Additionally, we experimentally demonstrate how the mode sorter works and explore the power and limitations of this method.

[1] Berkhout <i>et. al.</i> 2010 Phys. Rev. Lett. 105 153601

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Professor Andrew Forbes
andrew.forbes@wits.ac.za
University of Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 47 / **51**

Performance monitoring of a fabricated biogas digester fed with pig dung

Author: KeChrist Obileke[1]

Co-authors: Golden Makaka [2]; Patrick Mukumba [2]; Sampson Mamphweli [1]

[1] *Fort Hare Institute of Technology*

[2] *University of Fort Hare*

Corresponding Author: kcobileke@yahoo.co.uk

A 2.2 cubic metre volume biogas digester was designed, fabricated and tested for its performance using pig dung. The biogas digester was made of high density polyethylene (HDPE) plastic. The use of the plastic material was advantageous because the characteristic of defect such as cracks in the brick structure experience in the fixed dome type of biogas digester made of bricks or cement does not occur in plastic material. After the fabrication, the biogas digester was fed with pig dung to check its performance. The following parameter of the pig dung was examined; total solids, volatile solids, chemical oxygen demand and pH. The biogas composition and production were determined using a gas analyzer and mass flow meter respectively, while the pH of the slurry was measured using a digital pH meter. In the experiment, it was observed that the rate of biogas production from the pig dung increases as the retention time increases and later decreases after days of biodegradation. The optimum biogas yield was 2.30 cubic metre at pH of 6.8 during the 18th to 21st day of the study. Also, the study shows that pig dung is a potential substrate for biogas generation and should be encouraged. In conclusion, the methane yield of the pig dung was 60 %.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. Sampson Mamphweli.
smamphweli@ufh.ac.za
Fort Hare Institute of Technology
University Of Fort Hare
Alice, South Africa

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Photonics / **52**

Cell death induced by combination of phthalocyanine photosensitizer and doxorubicin on MCF-7 breast carcinoma cells.

Author: Eric Chekwube Aniogo[1]

Co-author: Blassan George [1]

[1] *Laser Research Centre, University of Johannesburg*

Cancer is one of the common diseases that affect and threatens our human existence. Breast cancer is an invasive heterogeneous disease and the second most common disease among woman worldwide. Virtually, curative degenerative diseases like cancer employ multiple therapeutic agents that targets different pathological processes. For this reason, combination therapy remains an alternative strategy to combat diseases like cancer. In this study, we evaluated the anticancer effect of phthalocyanine mediated photodynamic therapy in combination with low dose doxorubicin (0.5 μM) on MCF-7 cancer cells. In addition, we explore the cell death pathway elicited from the combination treatment. MCF-7 cells were incubated with low dose doxorubicin for 20 h, afterwards, various concentrations of phthalocyanine were added and further incubated for 4 h. Thereafter, the cells were irradiated with 681.5 nm diode laser at 4.55 wM/cm2 for 18 min 27 sec (5 J/cm2), and the cellular responses were measured. Cellular morphology was observed using inverted microscopy while the proliferation of cells was measured with homogenous ATP quantitative assay. The mechanism of cell death was investigated using Annexin V/PI flow cytometric analysis. Findings from this study shows that combination of phthalocyanine mediated photodynamic therapy and doxorubicin significantly enhances the anticancer efficacy of phthalocyanine-doxorubicin combination on MCF-7 cells than when used individually. It was observed that this combination treatment led to an apoptotic cell death pathway. Hence, this study suggests a new treatment opportunity for breast cancer to enhance its effectiveness and which warrants further investigation for its potential to reverse multidrug resistance.

Summary:

Successful stories in cancer therapy have been based on combination therapy. Low dose of doxorubicin was effectively utilized with PDT to inhibit MCF-7 cancer cell proliferation and ultimately induce apoptotic cell death. Thus this combination regime is highly recommended.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof. Heidi Abrahamse
Director: Laser Research Centre

NRF SARChI Chair: Laser Applications in Health
Faculty of Health Sciences
University of Johannesburg
Email: habrahamse@uj.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Physics of Condensed Matter and Materials 1 / 53

Mass-loading effect of graphene foam (GF) on the electrochemical performance of nickel phosphate as an electrode for supercapacitor application

Author: Abdulmajid A. Mirghni[1]

Co-authors: Kabir O. Oyedotun [1]; Moshawe J. Madito [1]; Ncholu Manyala [1]; Ndeye M. Ndiaye [1]; Tshifhiwa M. Masikhwa [1]

[1] *UP*

Corresponding Author: mergany85@gmail.com

This work presents the effect of different contents of graphene foam (GF) on the electrochemical capacitance of nickel phosphate Ni₃(PO₄)₂ nanorods as an electrode material for supercapacitor applications. Ni₃(PO₄)₂ nanorods were synthesized via a hydrothermal method followed by different mass loading of graphene (30, 60, 90 and 120 mg, denoted as Ni₃(PO₄)₂/30 mg GF, Ni₃(PO<sub>4</su mg GF, Ni₃(PO₄)₂/90 mg GF and Ni₃(PO₄)₂/120 mg GF, respectively. The electrochemical behavior of Ni₃(PO₄)₂ and Ni₃(PO₄)₂/GF nanorods composites were analyzed in a three-electrode cell using cyclic voltammetry (CV), galvanostatic charge−discharge (GCD) and electrochemical impedance spectroscopy (EIS) in a 6 M KOH electrolyte. The electrochemical tests showed that the specific capacitance increased with increasing the GF content up to 90 mg then decreased. The Ni₃(PO₄)₂/90 mg GF exhibited the highest specific capacitance of 606 F g⁻¹ (using CV curve) and 462 F g⁻¹ (using CD curve) at 5 mV s⁻¹ scan rate and 0.5 A g⁻¹ current density respectively. The high specific capacitance is attributed to good crystallinity and synergetic interaction of the GF and Ni₃(PO₄)₂ nanorods.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Ncholu Manyala, ncholu.manyala@up.ac.za, University of Pretoria

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Nuclear, Particle and Radiation Physics 1 / 54

Resonances in odd-odd 182Ta

Author: C.P. Brits[1]

Co-authors: A. Gorgen [2]; A.C. Larsen [2]; Bonginkosi Kheswa [1]; D. Bleuel [3]; E. Sahin [2]; F. Giacoppo [2]; F.B. Zeiser [2]; F.L. Bello Garrotte [2]; G.M. Tveten [2]; H.T. Nyhus [2]; K. HADYNSKA-KLEK [2]; Kgashane Malatji [1]; M. Guttormsen [2]; M. KLINTEFJORD [2]; Mathis Wiedeking [1]; Paul Papka [4]; S Siem [2]; S. Rose [2]; T. Renstrom [2]; T.W. Hagen [2]; V.W. Ingeberg [2]

[1] *iThemba LABS*

[2] *University of Oslo*

[3] *Lawrence Livermore National Laboratory, USA*

[4] *Stellenbosch University*

Relatively small resonances on the low-energy tail of the giant electric dipole resonance such as the scissors or pygmy resonances can have significant impact on reaction rates. These rates are important input for modelling processes that take place in astrophysical environments and nuclear reactors. Recent results from the University of Oslo indicate the existence of a significant enhancement in the photon strength function for nuclei in the actinide region due to the scissors resonance [1]. Further, the M1 strength distribution of scissors resonances in rare earth nuclei has been studied extensively over the years [2]. In order to investigate the extent and persistence of the scissor resonance in other mass regions, an experiment was performed utilizing the NaI(Tl) gamma-ray detector array (CACTUS) and silicon particle telescopes (SiRi) at the cyclotron laboratory at the University of Oslo. Particle-gamma coincidences from the 181Ta(d,p)182Ta reaction were used to measure the nuclear level density and photon strength function of the well-deformed 182Ta system, to investigate the existence of resonances below the neutron separation energy. In this talk I will present and discuss the final results of this investigation and place our findings in the context of previous work.

[1] M. Guttormsen et al. Phys. Rev. Lett. 109, 162503 (2012).
[2] P. von-Neumann-Cosel, K. Heyde, and A. Richter, Rev. Mod. Phys., 82, 2365,
(2010).

This work is based on the research supported in part by the National Research Foundation of South Africa Grant Number 92600.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Dr. Mathis Wiedeking
wiedeking@tlabs.ac.za
iThemba LABS

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 48 / **55**

RFQ accelerator beam optimization at Necsa

Author: Tshepo Mahafa[1]

Co-author: Graham Daniels [1]

[1] *Necsa*

A process of beam optimization was carried out at Necsa following changes made to the HEBT system of the accelerator. This was done to establish the most optimal beam conditions that ensures adequate beam transport is achieved and maintained during acceleration. The optimization method and work will be presented which will detail the 3 step process followed that involved TRACE 3D simulation, quadrant analysis for beam positioning, and a beam to target run for identifying beam position and determining beam size.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

No

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Physics of Condensed Matter and Materials 1 / 56

Investigation of the Magnetic Ground State of PrRu₂Ga₈ Compound

Author: Michael Olawale Ogunbunmi[1]

Co-authors: Andre Strydom [1]; Buyi Sondezi [1]

[1] *University of Johannesburg*

We have investigated the ground state properties of the orthorhombic structure compound PrRu₂Ga₈ which was first announced by the group of Jeitschko [1]. The compound crystallizes in the CaCo₂Al₈-type structure, belonging to space group <i>Pbam</i> (No. 55). Specific heat data shows a λ-type anomaly at <i>T_N</i> = 3.3 K, indicating a bulk phase transition probably of antiferromagnetic nature. At the Neel temperature, <i>T_N</i> the entropy approaches the value of 4.66 J/mol.K which is about 0.8Rln2, where R is the universal gas constant. The dc magnetic susceptibility, $\chi(T)$ confirms the anomaly at 3.3 K while $1/\chi(T)$ follows the Curie-Weiss law down to low temperatures, with the calculated effective magnetic moment, μ_{eff} = 3.47(2) μ_B and paramagnetic temperature, θ_p = −7.8(1) K. This magnetic moment value is in good agreement with the Hund's rule theoretical value of 3.58 μ_B for a free Pr³⁺ ion. The electrical resistivity data also show an anomaly at <i>T_N</i> and follows a metallic behavior at high temperatures. The Pr³⁺ in this structure type has a site symmetry of <i>Cs</i> which predicts a crystal electric field (CEF) splitting of the <i>J</I> = 4 multiplet into 9 singlets and thus rule out in principle the occurrence of spontaneous magnetic order. In this work we discuss the magnetic order in PrRu₂Ga₈ in line with an induced type of magnetism resulting from the admixture of the lowest CEF level with the higher ones [2].

Summary:

Keywords: Induced magnetism, Pr-magnetism, crystal electric field

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. A.M. Strydom, amstrydom@uj.ac.za
University of Johannesburg

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Space Science / **57**

Multi-wavelength observations and modelling of solar energetic particles

Author: Du Toit Strauss[1]

Co-authors: Jabus van den Berg [2]; Phillip Heita [3]; Ruhann Steyn [4]

[1] *Centre for Space Research, North-West University*

[2] *North West University*

[3] *Center for Space Research, North-West University*

[4] *Student*

Corresponding Author: dutoit.strauss@gmail.com

Solar energetic particles (SEPs) are highly relativistic, non-thermal particles, accelerated in/near the solar corona during transient solar phenomena. SEP electrons are believed to be mainly accelerated by magnetic reconnection occurring in solar flares. For these events, we may infer a lot about how and where these particles are accelerated and when they are released into the turbulent interplanetary medium by examining the electromagnetic radiation they produce during their propagation. In this talk we will discuss these remote-sensing observations of the Sun, how the transport of SEP electrons are modelled, and how we may use the SEP electron observations to mitigate possible harmful space weather events.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Nuclear, Particle and Radiation Physics 1 / **58**

Calculation of the nuclear optical potential and elastic scattering observables for unstable nuclei using a relativistic formalism

Author: Wasiu Yahya[1]

Co-author: Brandon Van der Ventel [1]

[1] *Stellenbosch University*

Corresponding Author: wyahya@sun.ac.za

The ground state properties of unstable nuclei are studied using the following relativistic mean field (RMF) models: QHDI, QHDII, NL3, and FSUGold. The bound state wave functions obtained from these RMF calculations are then folded with the nucleon−nucleon (NN) interaction to obtain the nuclear optical potential. Two models for the NN interaction are considered: the IA1 parametrization, and a general Lorentz−invariant form, called the IA2 model. The scattering observables are calculated for projectile proton scattering at various intermediate energies of 200 MeV, 300 MeV, and 500 MeV, by solving the Dirac equation. The results for the IA1 and IA2 models will be compared.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof BIS Van der Ventel

bventel@sun.ac.za

Stellenbosch University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 08 / **59**

Comparative performance of CdS/CdTe thin film solar cells fabricated with electrochemically deposited CdTe from 2-electrode and 3-electrode set-ups.

Author: Obi Kingsley Echendu[1]

Co-author: Birhanu Francis Dejene [1]

[1] *Department of Physics, University of the Free State, Qwa qwa Campus, Private bag X13, Phuthaditjhaba, 9866, South Africa*

Corresponding Author: oechendu@yahoo.com

A comparative study of the performance of thin film glass/FTO/CdS/CdTe/Au solar cells has been carried out for solar cells fabricated with CdTe electrochemically grown using 2-electrode and 3-eletrode set-ups. Structural and optical characterization of the CdTe films prior to solar cell fabrication shows that both electrode set-ups produce CdTe with similar x-ray diffraction patterns and optical absorption properties. Current density-voltage characterization of the resulting un-optimized solar cells also show that CdTe from both electrode systems produced solar cells of comparable conversion efficiencies in the range (3.0 – 6.5)%. The open-circuit voltage, short-circuit current density and fill factor for cells from both systems were in the range (410 – 630) mV, (15.2 – 31.8) mAcm-2 and (0.32 – 0.49) respectively. These results demonstrate that the 2-electrode electrodeposition is as good as the conventional 3-electrode counterpart in producing semiconductors without compromising their essential device qualities. This becomes important more so as the elimination of the relatively expensive reference electrode commonly used in 3-electrode set-up will go a long way to reducing the cost of producing thin film solar cells and other devices based on eletrodeposition technique.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

B. F. Dejene. dejeneBF@ufs.ac.za
University of the Free State

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 09 / **61**

Synthesis and characterization of mixed hydroxide NiCo(OH)2 and NiCoMnO2 nanocomposites for high performance supercapacitors

Authors: Kabir Oyedotun[1]; Ncholu Manyala[1]

Co-authors: Abdulmajid Mirghni [1]; Abubakar Khaleed [1]; Damilola Momodu [1]; Moshawe Madito [1]

[1] *UP*

Corresponding Author: kabir.oyedotun@gmail.com

Currently, energy storage devices materials with controlled morphology and properties can be prepared using simple and low temperature stirring technique. The technique is relatively simple, cost effective and suitable for sample preparation.

In this work, we report the synthesis and characterization of environmentally friendly mixed hydroxide NiCo(OH)2 and NiCoMnO2 electrodes successfully fabricated via a low temperature, simple and effective stirring process. The electrodes were prepared by force-driven hydrolysis of hydrated nitrates of nickel, cobalt and manganese salt at a temperature of 40℃ for 2 hours. The structure and morphology of the sample were characterized using X-Ray powder diffraction (XRD) and high magnification scanning electron microscopy (HM-SEM). The electrochemical performance of the samples was characterized by using galvanostatic charge-discharge test on the prepared electrodes in alkaline electrolyte. X-ray diffraction and scanning electron microscopic studies showed that the materials are crystalline and well distributed. XRD results indicate that the composite material is fairly crystalline and multiple phase structure. SEM images reveal a fairly correlated morphological differences between the samples with the NiCo(OH)2 having agglomerated bigger grains compared to the less crystalline NiCoMnO2 with smaller but evenly distributed grains. The electrochemical performance showed a significant difference with the NiCoMnO2, which displays higher capacity and better cycling stability which is considered to be as a result of its smaller grains size and the large specific surface area.

Summary:

NiCoMnO2 composite electrode has been successfully prepared using nickel cobalt manganese hydroxide as precursor via simple and low temperature stirring process. The nanograin and meso-porous structure provide the as-synthesized NiCoMnO2 electrode with high diffusion rate of electrons and ions in the matrix of the material resulting in the enhanced electrochemical performance. The as-synthesized NiCoMnO2 electrode exhibits a high specific capacitance/capacity (1203 Fg-1/132.1 mAhg-1), good cycle stability as well as good rate capability. After 1000 cycles, the efficiency of the electrode is observed to only decrease by 6.8 % of the initial capacity showing improved electrochemical stability. Electrodes with desired thickness, good uniformity, enhanced electrochemical properties and high throughput could be prepared through this simple and cost effective process. The as-synthesized NiCoMnO2 electrode material is a promising candidate for applications in energy storage devices.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. N. Manyala; ncholu.manyala@up.ac.za; University of Pretoria.

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 10 / **62**

Effect of growth time of hydrothermally grown VO2 for supercapacitors applications

Authors: Ncholu Manyala[1]; Ndeye Maty Ndiaye[1]

Co-authors: Aboubaker C Beye [2]; Balla Diop Ngom [2]; Jack. Madito Madito [1]; Julien K Dangbegnon [1]; Kabir O. Oyedotun [1]; Tshifhiwa Masikhwa [1]

[1] *UP*

[2] *UCAD*

Corresponding Author: nmaty.ndiaye@gmail.com

In this work, we report the time-dependent synthesis of VO2 microspheres and nanosheets by hydrothermal method with a systematic improvement in physical and electrochemical properties such as specific surface area and specific capacitance at synthesis time of 6 h. VO2 microspheres and nanosheets were characterized by SEM, BET and XRD. The results show that variation of reaction time plays a crucial role in the transformation of samples morphology. VO2 microspheres synthesized within 4 h represents the intermediate reaction time between VO2 microsphere and nanosheets. VO2 grown at 6 h under the same synthesis conditions exhibited the highest specific capacitance of 485 F g-1 at a current density of 0.5 A g-1 in 6 M KOH electrolyte using Ni foam as a current collector and also showed excellent stability with ~ 98.5 % capacitance retention after 1000 cycles at a current density of 10 A g-1. Based on the above results, the VO2 nanosheets show a considerable potential as electrode materials for supercapacitor applications.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. Ncholu Manyala, Ncholu.Manyala@up.ac.za, University of Pretoria, Hatfield, Pretoria.

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Photonics / **63**

Light can be fractal!

Author: Hend SROOR[1]

Co-authors: Andrew Forbes [2]; Darryl Naidoo [3]; Johannes Courtial [4]

[1] *University of The Witwatersrand*

[2] *CSIR*

[3] *Council for Scientific and Industrial Research*

[4] *Glasgow University*

Corresponding Author: hend@aims.ac.za

Fractal is a mathematical series that manifests replicated patterns at every scale. If the repeated patterns are identical in each scale, the fractal in this case is called a self-similar fractal. That type of fractal is described by a mathematical equation which is nowhere differentiable. Fractals have found their way in applications such as fractal antennas and transistors, digital imaging as well as fractal cosmology science.

Theoretical simulations show that unstable laser resonators contain a special plane, self-conjugate plane, in which the eigenmodes not only have the same pattern but the eigenmodes are magnified copies of themselves. Here, we introduce a new design for laser resonator that are capable of generating eigenmodes with self-similar fractal features. The fractal feature is proved by finding a typical image of the eigenstate at different scales as well as by calculating the fractal dimensions of the eigenstates.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

phd

**Main supervisor (name and email)
and his / her institution**:

Prof.Andrew Forbes
andrew.forbes@wits.ac.za
University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

no

Poster Session 1 - Board: 11 / **64**

Gas-Sensing Properties of TiO₂ Nanoparticles Double Doped with Ag and Cu

Author: Olatunbosun Nubi Nubi[1]

Co-author: Thuto Mosuang [1]

[1] *University of Limpopo*

Corresponding Author: olatunbosun.nubi@ul.ac.za

Nanometric powders of titanium dioxide (TiO₂) were prepared by the sol-gel synthesis of titanium isopropoxide. With Ag and Cu as dopants, single and double doped samples, at doping levels of 5% molar weight, were achieved. In addition, undoped samples were also prepared. The samples were dried in air at 100℃ and post annealing was done at 300℃ and 900℃, in order to obtain the anatase and rutile polymorphs respectively. The changes in the electrical conductivities of representative anatase and rutile TiO₂ nanopowders upon exposure to water-vapour, ammonia (NH₃) and hydrogen (H₂) were then investigated. Sensing measurements for water-vapour was done at room temperature for various humidity levels ranging from 5.4% RH to 88.4% RH. The detection of NH₃ and H₂ gases were carried out at temperatures extending from room temperature to 350℃ and over concentration ranges of 25 sccm to 500 sccm and 15 sccm to 200 sccm respectively. The gas-sensing results show that the sol-gel fabricated TiO₂ nanoparticles (particularly in anatase form), has excellent fast and stable dynamic responses to humidity, NH₃ and H₂. They feature good sensitivities, even at a low operating temperatures. However, acceptor behaviour, for which there was a conductivity switch from n-type to p-type, was recorded for the Ag-doped rutile powders at operating temperatures of 300℃ and 350℃. Overall, the double-doped sample annealed at 300℃ was deemed the most promising candidate for gas-sensing.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Physics of Condensed Matter and Materials 1 / 65

Evolution of “spinel-layered-spinel” Composites in the Li-Mn-O Nanoarchitectures

Author: Raesibe Sylvia Ledwaba[1]

Co-authors: Dean Sayle [2]; Phuti Ngoepe [3]

[1] *Physics*

[2] *University of Kent*

[3] *University of Limpopo*

Corresponding Author: raesibeitm@gmail.com

The fast lithium ion diffusion kinetics and superior high rate capability of 2D (nanosheets) and 3D (nanoporous) nanoarchitectures have ignited interest in their utilization as electrode materials for lithium ion batteries. The exceptional performance properties are mainly due to the large surface area of these small particles leading to the shortened lithium ion and electron diffusion path within 3D channels of the electrode material during cycling process, compared to the parent bulk [1, 2]. In the current study, simulated amorphization and recrystallization technique will be employed to generate the nanoarchitectures as was previously employed to generate nano-architectures of binaries such as MnO2 [3] and ternary Li2MnO3 [4]. A wealth of crystallographic defects was captured i.e. grain boundaries and point defects. Microstructures of the resulting models conformed to the spinel polymorph and also indicated the presence of spinel Mn3O4 and layered-Li2MnO3. XRD patterns compare favourably with experimental XRDs providing validation of composite formation.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof P.E. Ngoepe, phuti.ngoepe@ul.ac.za, University of Limpopo

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Photonics / 66

Photobiomodulation activates the JAK/STAT signaling pathway in diabetic wounded cells in vitro

Author: Sandy Jere[1]

Co-author: Nicolette Houreld [1]

[1] *Laser Research Center, University of Johannesburg*

Corresponding Author: sandywjere@gmail.com

The Janus Kinase/Signal Transducer and Activator of Transcription (JAK/STAT) signaling pathway consists of four JAK and seven STAT family members. It is involved in the transmission of external signals via receptors to the nucleus, resulting in transcription and downstream events such as cellular proliferation and migration. Wound healing is coordinated by complex signaling cascades involving different growth factors, cytokines and chemokines. In diabetes, wound healing is delayed due to various mechanisms including decreased cell proliferation and cytokine/growth factor response, with epidermal growth factor (EGF) being one such cytokine. Photobiomodulation (PBM) involves exposing wounds to lasers to induce wound healing, and has been shown to stimulate cellular migration and proliferation. However, the mechanism/s involved in these observations are not well understood. The aim of this investigation was to determine if PBM activates the JAK/STAT signaling pathway leading to cellular migration and proliferation in a diabetic wounded cell model. In this investigation, WS1 human skin fibroblast cells were exposed to a continuous wave diode laser at 660 nm with a fluence of 5 J/cm2. Diabetic cells were continuously grown in media with an additional 17 mM/L glucose. A monolayer of WS1 cells were wounded by performing a central scratch. Diabetic wounded cells cultured in the presence or absence of exogenous human recombinant EGF (rhEGF), an inducer of cell proliferation, were irradiated and incubated for 48 h. AZD1480, a JAK2 inhibitor, was used to inhibit cell proliferation, migration and wound repair. Exogenous rhEGF treated, AZD1480 treated and non-irradiated (0 J/cm2) cells served as controls. Cellular migration was monitored microscopically every 12 h for 48 h by doing time-lapse. Expression of EGF and phosphorylation of its receptor (EGFR), as well as JAK2, STAT1 and 3 was analyzed by the enzyme linked immunosorbent assay (ELISA) and immunofluorescence microscopy. PBM at 660 nm with 5 J/cm2 significantly increased expression of EGF, phosphorylation of EGFR, JAK2, STAT1 and 5, and increased cellular migration. AZD1480 significantly reduced cellular proliferation and migration. PBM of diabetic wounded cells at 660 nm with 5 J/cm2 stimulates migration and proliferation of cells via expression of EGF which binds to and phosphorylates EGFR which in turn leads to the activation of the JAK/STAT pathway.

Summary:

PBM of diabetic wounded cells in vitro at 660 nm with 5 J/cm2 stimulates migration and proliferation of cells

**Apply to be
 considered for a student
   award (Yes / No)?**:

YES

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof Nicolette Houreld
Associate Professor; Laser Research Centre

Faculty of Health Sciences
Room 5306e, John Orr Building, Doornfontein Campus
PO Box 17011, Doornfontein, 2028
Email: nhoureld@uj.ac.za
Tel: +27 11 559 6833
Fax +27 11 559 6884

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 56 / **67**

Hybrid Poincare beams from the source

Author: Hend SROOR[1]

Co-authors: Andrew Forbes [2]; Darryl Naidoo [3]

[1] *University of The Witwatersrand*

[2] *CSIR*

[3] *Council for Scientific and Industrial Research*

Corresponding Author: hend@aims.ac.za

Current laser cavities are designed in such a way as to generate fundamental Gaussian modes, however, these modes are not suited for the application in hand which raise the need for higher-order modes. Examples of such modes are the higher-order vector vortex modes which are spatial modes of light with a non-uniform polarization distribution. These higher-order modes are routinely generated in the laboratory outside a laser cavity, using a variety of polarization optics, and through manipulation of the dynamic and geometric phase of light. Inside the laser cavity however, controlling higher-order modes has proven to be a non-trivial task especially in separating degenerate higher-order laser modes such as Laguerre Gaussian vortex modes, as they possess identical propagation characteristics, intensity distributions and size. The experimental realization of other higher-order beams directly from a laser cavity is also a non-trivial task with little evidence of control to-date. Furthermore, current detection schemes for laser modes are only effective for low order modes, however, the efficient sorting of very high order modes remains topical. We experimentally demonstrate an optical resonator that could generate intra-cavity first order Laguerre Gaussian mode. Lastly, we show how the system the system will be manipulated to generate modes with large orders (greater than 100).

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. Andrew Forbes
andrew.forbes@wits.ac.za
University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Photonics / 68

Quantum-statistical phenomenon of sustainability and its manifestations in dissipative photonic systems

Author: Konstantin Zloshchastiev[1]

[1] *Durban University of Technology*

Corresponding Author: bozons@gmail.com

It is shown that sustainability is a universal quantum-statistical phenomenon, which emerges during propagation of photons inside different dissipative media, such as waveguides, metamaterials or biological tissues. These quantum effects occur due to the interaction of electromagnetic (EM) waves or photons with their environment, which can be described by means of the reduced density operator and effective non-Hermitian Hamiltonian (NH) approach. We illustrate them using two seemingly entirely different kinds of photonic systems: (1) We start by considering EM wave propagation in dielectric linear media, for which we derive the effective Hamiltonian operator, which describes such propagation. This operator turns out to be essentially non-Hermitian. Using the density operator approach for general non-Hermitian Hamiltonians, we derive a master equation that takes into account statistical ensembles of EM wave modes. The method describes dissipative processes which happen during the wave's propagation, and, among other things, it reveals the conditions that are necessary to control the energy and information loss inside the above-mentioned materials. (2) In case of photobiological complexes (PBCs), such as photosynthetic reaction centers and centers of melanogenesis inside living organisms or organelles, we derive a simple effective model of excitonic energy transfer. We demonstrate that photobiological systems must be both quantum and sustainable for them to simultaneously endure continuous energy transfer and keep their internal structure from destruction or critical instability. We show that in sustainable PBCs, quantum effects survive on a much larger time scale than the energy relaxation of an exciton. Besides, sustainable evolution significantly lowers the entropy of PBCs and improves the speed and capacity of energy transfer therein.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Space Science / 69

An introduction to diffusive shock acceleration in space sciences

Author: Phillip Prinsloo[1]

Co-author: Du Toit Strauss [2]

[1] *Centre for Space Research, North-west University*

[2] *Centre for Space Research, North-West University*

Corresponding Author: drageoprinsloo@gmail.com

Diffusive shock acceleration is thought to be a primary mechanism by which particles gain energy at shock waves in magnetized media. We provide an introduction to the basic physics of these

shocks and the associated acceleration of non-thermal charged particles, and explain how the effects of this acceleration mechanism are incorporated into models of energetic particle transport in the heliosphere. Furthermore, we illustrate the relevance of shock acceleration in the context of space sciences, discussing its involvement at the solar wind termination shock and during space-weather events, such as coronal mass ejections and the acceleration of energetic storm particles.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Dr RD Strauss, Dutoit.Strauss@nwu.ac.za, North-West University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Physics of Condensed Matter and Materials 1 / 70

Intermediate Valence behavior in the new ternary compound Yb₁₃Pd<

Author: Redrisse Djoumessi Fobasso[1]

Co-authors: Andre Strydom [1]; Federica Gastaldo [2]; Ivan Curlik [3]; Marian Reiffers [3]; Mauro Giovannini [2]

[1] *University of Johannesburg*

[2] *University of Genova*

[3] *University of Prešov*

Corresponding Author: redrisse.djoumessi@aims-cameroon.org

The new ternary intermetallic compound Yb₁₃Pd₄₀Sn₃₁ was obtained as part of the investigation of the isothermal section of the Yb-Pd-Sn system at 600℃ [1]. The polycrystalline sample was prepared by induction melting method in sealed tantalum crucible under a stream of pure argon gas. The powder x-ray pattern indicated that the sample crystallizes in a hexagonal structure, similar to hP168-Yb₁₃Pd₄₀Sn₃₁ [1]. Magnetic susceptibility measurement depicted a strange and non-regular temperature dependence in applied magnetic field of 0.01 T. The inverse magnetic susceptibility does not obey Curie-Weiss law throughout the measured temperature range (400 K – 2 K).This behavior is unexpected for Yb in its magnetic Yb³⁺ state and suggests that the system is well described by the interconfiguration fluctuation (ICF) model, having an unstable valence for Yb ion. The temperature dependent electrical resistivity shows that the compound becomes superconducting below 2.3 K, however, there are some speculations about the bulk character of this superconductivity ground state. Specific heat analysis shows that the anomaly at 2.3 K survives even in 1 T but is completely suppressed in B = 4 T. As a most important discovery, we observe that, aside from the peak at T_{sc}, there is an enormous upturn in the Cp(T)/T vs T graph towards lowest temperature than can be assigned as a first thought to a form of nuclear entropy.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof. Andre M. Strydom

University of Johannesburg

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 12 / **71**

Characterization of Ce3+ doped ZnO nano-powders co-doped with different concentrations of Eu3+ in polymer films of PVC, PCL and PVC/PCL blends

Author: Moipone Alice Malimabe[1]

Co-authors: Hendrik Swart [2]; Jeremia Sefadi [3]; Karel Von Eschwege [4]; Lehlohonolo F Koao [1]

[1] *University of the Free State (Qwaqwa)*

[2] *University of the Free state*

[3] *Sol Plaatje University*

[4] *University of the Free State*

Corresponding Author: mokoenama@ufs.ac.za

Luminescent nanoparticles are used in many fields of applications, such as bio-imaging, nano-sensors as well as in light emitting diodes. Nanoparticles of ZnO and Ce3+ doped ZnO co-doped with Eu3+ are synthesized by the chemical bath deposition method and then embedded in polymer matrixes of PVC, PCL and a PVC-PCL blend via the solution casting method. The optical properties of these polymer based Ce3+ doped ZnO co-doped with different concentrations (x %) Eu3+ nanomaterials were studied. Parameters such as transmittance, absorption coefficient and energy band gap were determined by employing the Tauc's plot. UV-Vis spectra of the polymer films showed a slight decrease in the band gap energy when Ce3+ doped ZnO co-doped with various amounts of Eu3+ nano-powders were dispersed through the polymer matrix. Scanning electron microscope showed that ZnO nanoparticles were found to spread more homogeneously in the PVC-PCL blend matrix than though the matrix of the unit polymers of PVC or PCL. The photoluminescence results showed polymer films exhibited a luminescence band around 444 nm. Eu3+ in the co-doped nanoparticles brought about an increase in the luminescent intensity of the polymer films at excitations around 252, 286 and 326 nm. Further increase in intensity was found when the PVC-PCL blend matrix was used. This increase is attributed to the effective interaction between the nanoparticles of Ce3+ doped ZnO co-doped with x % of Eu3+ and the PVC-PCL blend matrix.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Dr Lehlohonolo F Koao, email: koaolf@ufs.ac.za, University of the Free State (Qwaqwa Campus), Department of Physics

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 76 / **72**

First-principles studies of Te line-ordered alloys in a molybdenum disulfide monolayer

Author: NOELIARINALA FELANA ANDRIAMBELAZA[1]

Co-authors: Edwin Mapasha [1]; Nithaya Chetty [1]

[1] *University of Pretoria*

Corresponding Author: arinala.f@gmail.com

The electronic and optical properties of a two dimensional (2D) semiconductor materials (MoS₂, MoSe₂, MoTe₂, etc.) are usually controllable by tuning their band gaps to meet the requirements of various electronic applications. The band gap of a molybdenum disulfide (MoS₂) monolayer can be tuned by creating alloys either at the molybdenum (Mo) sites or sulfur (S) sites. Different alloy isomers such as random, line and cluster configurations can be formed at each concentration. Computing all the possible alloy configurations using first-principles methods is practically impossible. In this work, the thermodynamic stability, structural and electronic properties of the Te line-ordered alloys at the S sites are investigated using the density functional theory (DFT) methods. Thirty four possible Te line-ordered alloy configurations are found in a 5×5 supercell of a MoS₂ monolayer. The calculated formation energies show that the Te line-ordered alloy configurations are thermodynamically stable at 0K. The lowest energy configuration at each concentration corresponds to the configuration where the Te atom rows are far away from each other (avoiding clustering). The variation in the lattice constants at different concentrations obeys Vegard's law. The Te line-ordered alloys fine tune the band gap of a MoS₂ monolayer although deviating from the linearity behavior. Our results suggest that the Te line-ordered alloys can be an effective way to modulate the band gap of a MoS₂ monolayer to fullfill the requirement of nanoelectronic, optoelectronic and nanophotonic applications.

Summary:

A systematic study of the Te line-ordered alloys in a MoS₂ has been considered. The lowest energy configuration at each concentration of the Te line-ordered alloys in a MoS₂ monolayer has been identified. The incorporation of the Te line-ordered alloys affects the lattice constant as well as the electronic properties of the MoS₂ monolayer. The lattice constant variation obeys Vegard's law and the band gap of the 2D MoS₂ is tuned from 1.65 eV to 1.04 eV. This range of band gap is related to the solar spectrum, indicating the importance of this study in optoelectronic and photonic devices.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof Nithaya Chetty
Nithaya.Chetty@up.ac.za
Department of Physics
University of Pretoria

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 13 / **73**

Thermal stability of perovskite precursors

Author: Thembinkosi Donald Malevu[1]

[1] *University of The Free State*

We report on a thermal stability of Perovskite solar cells precursors (CH3NH3I and PbI2) synthesized following a simple precipitate method. The structure, morphology, mass loss behavior, thermal behavior and thermal stability of these materials were investigated using X-ray diraction (XRD), Scannig electron microscpoe (SEM), Dierential scanning calorimetry (DSC), Fourier transform infrared spectroscopy (FTIR)
and Thermogravimetric analysis (TGA), respectively. XRD measurements indicated the presence of both organic and inorganic materials. SEM analyses revealed that both materials have similar morphologies that makes it compatible to work as a loyal active layer. TGA analysis suggested that both CH3NH3I and PbI2
components are stable at temperatures up to 244 degrees celsius and 500 degrees celsius, respectively. The various functional groups present both CH3NH3I and PbI2 components were identified by FTIR analysis

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Ocaya R.O

University of the Free State

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Poster Session 1 - Board: 14 / **74**

Thermal and electrical transport properties of Sm₃Rh<sub>4</su compound

Author: Sindisiwe Xhakaza[1]

Co-authors: Andre Strydom [2]; Buyi Sondezi [2]

[1] *Highly Correlated Matter Research Group, Department of Physics, University of Johannesburg, South Africa*

[2] *University of Johannesburg*

Polycrystalline samples of Sm₃Rh₄Ge₁₃ compound was synthesized by arc melting the stoichometric quntities of respective purity elements. The compounds crystallize in the usual cubic structure, space group <i>Pm¯3n</i> (#223) [1-2]. Our magnetic susceptibility measurements show antiferomagnetic behavour at low temperatures, at T_N = 5 K, for Sm₃Rh₄Ge₁₃. The high temperature data of the inverse magnetic susceptibility deviates from Curie-Weiss behaviour, and rather obey modified Curie-Weiss law. This work will focus on thermoelectric properties of the system where, our electrical resistivity data depict a semiconducting nature by virtue of a systematic negative coefficient of temperature dependance and overall values of resistivity that are not within the normal-metal range. The measured thermal transport properties values of Sm3Rh4Ge13 exhibit low thermal conductivity and fairly high and positive thermopower suggesting that the fermi surface in these materials is hole dominated.

Summary:

Reference:
[1] J. L. Hodeau, J. Chenavas, M. Marezio, J. P. Remeika, Solid State Commun. 36 (1980) 839–845.
[2] R. Gumeniuk et al. Dalton Trans. 41 (2012) 6299–6309.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof Andre Michael Strydom
amstrydom@uj.ac.za
University of Johannesburg

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Physics of Condensed Matter and Materials 1 / 75

Electrical characterization of deep level defects created by bombarding the n-type 4H-SiC with 1.8 MeV proton irradiations

Author: Ezekiel Omotoso[1]

Co-authors: Alexander Paradzah [2]; Danie Auret [3]; Johan Janse van Rensburg [3]; Walter Meyer [3]

[1] *University of Pretoria, Pretoria, South Africa*

[2] *MSc Student*

[3] *University of Pretoria*

Corresponding Author: ezekiel.omotoso@up.ac.za

We have characterized the deep level defects present before and after proton irradiation and annealing of n-type, N-doped, 4H-SiC using deep level transient spectroscopy (DLTS). The bombardment of the sample was carried out at fluence of 1.0 × 1012 cm−2. The suitability of Schottky barrier diodes (SBDs) was tested before and after proton irradiation and annealing by current–voltage (I-V) and capacitance–voltage (C-V) carried out at room temperature. I-V and C-V results revealed a degradation of the (SBDs) properties after proton irradiation. Rectification properties of the SBDs were restored gradually after annealing in flowing argon at temperatures varies from 125 to 625 ℃. Presence of four electron traps (Ec − 0.10, Ec − 0.13, Ec − 0.18 and Ec − 0.69 eV) were observed in as-grown diodes. Deep level defects, Ec − 0.42 and Ec − 0.76 eV, were revealed after annealing the proton-irradiated SBDs up to 225 ℃, while Ec − 0.42 eV later annealed out at 425 ℃ which led to changes in the spectrum shown in Fig. 1. The disappearance of Ec − 0.42 eV also probably led to the appearance of two electron traps (Ec − 0.31 and Ec − 0.62 eV) at annealing temperature of 425 ℃. We speculate that the defect Ec − 0.42 eV has a link or relationship with defects Ec − 0.31 and Ec − 0.62 eV, respectively. The defects, Ec − 0.31 eV, remained up to high temperature annealing, has a similar energy with defect Ec − 0.32 obtained after electron irradiation, though unstable, which has been attributed to a carbon interstitial.

Summary:

Proton irradiation with 1.8 MeV introduced deep level defects into thermally fabricated Ni/4H-SiC. These defects emanated were characterized by deep level transient spectroscopy. Annealing the irradiated devices revealed the presence of two new defects.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Main supervisor (name and email)
and his / her institution:**

Prof. W.E. Meyer
University of Pretoria

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Theoretical and Computational Physics 1 / 76

Steady states of Open Quantum Brownian Motion

Author: Ilya Sinayskiy[1]

Co-author: Francesco Petruccione [2]

[1] *University of KwaZulu-Natal and National Institute for Theoretical Physics*

[2] *UKZN*

Open Quantum Brownian Motion (OQBM) describes a Brownian particle with an additional internal quantum degree of freedom. Originally, it was introduced as a scaling limit of Open Quantum Walks (OQWs). Recently, it was noted, that for the model of free OQBM with a two-level system as an internal degree of freedom and decoherent coupling to a dissipative environment, one could use weak external driving of the internal degree of freedom to manipulate the steady-state position of the walker [Sinayskiy, I., and Petruccione, F. (2016). Fortschr. Phys. doi:10.1002/prop.201600063]. This observation establishes a useful connection between controllable parameters of the OQBM, e.g. driving strengths and magnitude of detuning, and its steady state properties. Although OQWs satisfy a central limit theorem (CLT), it is known, that OQBM, in general, does not. The aim of this work is to derive steady states for some particular OQBMs and observe possible transitions from Gaussian to non-Gaussian behavior depending on the choice of quantum coin and as a function of diffusion coefficient and dissipation strength.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Main supervisor (name and email)
and his / her institution:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Astrophysics / 77

MeerLICHT: MeerKAT's optical eye

Author: Kerry Paterson[1]

Co-authors: Brian Warner [1]; Patrick Woudt [2]; Paul Groot [3]; Paul Vreeswijk [4]; Steven Bloemen [3]; Vanessa McBride [5]

[1] *UCT*

[2] *Department of Astronomy, University of Cape Town*

[3] *Radboud University*

[4] *Weizmann Institute of Science*

[5] *University of Cape Town & SAAO*

Corresponding Author: ptrker004@myuct.ac.za

MeerLICHT is a 65cm optical telescope situated in Sutherland. The MeerLICHT project, as a part of the ThunderKAT project, will be linked to MeerKAT in real-time, in order to provide simultaneous optical and radio observations of the transient sky. Since transient events often requires multi-wavelength observations within a short time lapse, the combination of MeerLICHT and MeerKAT will provide invaluable information on emission at both wavelengths, including the relation and evolution of emission from both wavelength windows.

After the installation and commissioning of MeerLICHT in May-June 2017, early science on MeerLICHT has begun. This, along with testing the link between MeerLICHT and MeerKAT, will continue until MeerKAT is completed and released for science.

In this talk, I will present an overview of the MeerLICHT and ThunderKAT projects as a whole, an overview of the MeerLICHT pipeline, early science results obtained with MeerLICHT, as well as the timeline and future works of the projects.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. Patrick Woudt: pwoudt@ast.uct.ac.za
UCT

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 38 / **78**

Lambda-neutron potential through fixed-angular-momentum inversion

Author: Emile Meoto[1]

Co-author: Mantile Lekala [1]

[1] *UNISA*

Corresponding Author: emeotoson@gmail.com

Quantum systems with a strangeness degree of freedom are very important as they provide an extra dimension, and hence a deeper insight into nuclear matter. Usually phenomenological potentials

obtained through meson exchange theories have been used in investigating these hypernuclear systems. A lambda-neutron interaction constructed through fixed-angular momentum inversion based on the Marchenko Integral Equation is presented. Owing to experimental difficulties in producing a sufficient number of lambda-nucleon scattering events, theoretical phase shift data is used as input for the inversion. The potential obtained is energy-independent and has a soft core, making it more suitable for quantum-mechanical few-body calculations.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

None

**Main supervisor (name and email)
and his / her institution**:

Prof. Mantile L. Lekala (lekalml@unisa.ac.za) / UNISA

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Nuclear, Particle and Radiation Physics 1 / 79

Studies of the low lying E1 “Pygmy resonance” modes in ¹⁵⁴Sm using inelastic alpha scattering

Author: Harshna Jivan[1]

Co-authors: ELIAS SIDERAS-HADDAD [1]; Luna Pellegri [2]

[1] *University of the Witwatersrand*

[2] *University of Witwatersrand and iThemba LABs*

Corresponding Author: harshna.jivan@gmail.com

In this study, the low-lying electric dipole (E1) response referred to as the Pygmy Dipole Resonance (PDR) is investigated using the (alpha;,alpha;’gamma;) inelastic scattering reaction at 120 MeV on the deformed ¹⁵⁴Sm nucleus. Coincidence experiments were performed at the iThemba LABS using the K600 magnetic spectrometer in 0deg; mode and BaGeL (Ball of Germanium and LaBr detectors), an array of High-Purity Germanium (HPGe) and Lanthanum Bromide detectors. The use of an alpha probe enabled the isoscalar character of the PDR to be investigated, whilst the alpha;-&gamma coincidence allowed for the selection of specific decay channels.
The study is motivated by the need to further understand the underlying nature of the PDR. The PDR has been interpreted as an oscillation of the neutron excess against a proton-neutron saturated core. Its strength has been linked to the neutron skin by several theoretical approaches, providing possible constraints on the nuclear equation of state. These constraints play a vital role in the description of neutron stars. In addition, the PDR has an influence on reaction rates in the astrophysical r-process. In this talk, preliminary results will be presented and the methods employed for data extraction discussed.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. Elias Sideras-Haddad
Elias.Sideras-Haddad@wits.ac.za
University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Photonics / **80**

Optical sectioning with induced quantum optical coherence

Author: Adam Valles[1]

Co-authors: Gerard Jimenez [2]; Juan P. Torres [2]

[1] *School of Physics, University of the Witwatersrand, Private Bag 3, Wits 2050, South Africa*

[2] *ICFO—Institut de Ciencies Fotoniques, Mediterranean Technology Park, 08860, Castelldefels, Barcelona, Spain*

By making use of frequency-entangled photons we present a new type of optical coherence tomography (OCT) scheme, where the reflectivity of the sample translates in a change of coherence. We call this new approach induced optical coherence tomography (iOCT). This new scheme allows probing the sample with one wavelength and measuring light with another wavelength. As a result, we can gain penetration depth into the sample by using longer wavelengths, while still using the optimum wavelength for detection. Regarding the future work, we show the possibility to integrate this new iOCT scheme in a micro-chip by making use of semiconductor entanglement sources.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Juan P. Torres, juanp.torres@icfo.eu
ICFO—Institut de Ciencies Fotoniques, Mediterranean Technology Park, 08860, Castelldefels, Barcelona, Spain

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Nuclear, Particle and Radiation Physics 1 / **81**

High-fidelity modelling of the Egyptian 2nd Testing Research Reactor (ETRR-2)

Author: Maurice Mashau[1]

Co-authors: Francois Van Heerden [1]; Suzanne Groenewald [1]

[1] *Necsa*

This study forms part of the on-going IAEA Coordinated Research Project (CRP) which primarily focuses on benchmarking computational tools against experimental data for research reactors. It is important to benchmark these tools against experimental data as part of evaluating their capabilities in simulating physical phenomena which take place during reactor operation. Necsa has recently developed a new high-fidelity framework for performing nuclear reactor core calculations, which integrates both stochastic and deterministic modelling methods in a consistent way. In this work, this new calculational system is applied to the ETRR-2 benchmark problem in aid of code validation. In particular, a series of control rod calibration experiments are modelled as initial qualification of the model, where-after a series of cycle depletion analysis are conducted to validate the burn-up capability of the package.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Photonics / **82**

Development of a Supercontinuum based Nonlinear Optical Microscopy setup

Author: George Okyere Dwapanyin[1]

Co-authors: Erich Rohwer [1]; Pieter Neethling [1]

[1] *Stellenbosch University*

Corresponding Author: 19724020@sun.ac.za

Nonlinear Optical microscopy (NLOM) has been used in recent years in probing biological tissues both <i>in vivo</i> and <i>in vitro</i> due to its numerous advantages such as intrinsic 3D imaging with submicron spatial resolution, decreased photodamage, increased depth of penetration and the ability to perform label-free imaging. The integration of a broadband supercontinuum (SC) light source within a NLOM setup provides the versatility of accommodating multiple imaging modalities in a single setup, while also increasing the intensity of the output signal as a result of the high peak intensity achieved through temporal pulse compression of the SC pulse. This research focuses on the development of a SC based NLOM setup with a broadband source generated from a passive highly nonlinear All Normal Dispersion Photonic Crystal Fiber (ANDi-PCF). Spectral phase distortions caused by the nonlinear properties in the PCF are also characterized and corrected using a Multiphoton Intrapulse Interference Phase Scan (MIIPS) compression algorithm. Preliminary results will be shown and discussed.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. Erich Rohwer (egr@sun.ac.za), Stellenbosch University
Dr. Pieter Neethling (pietern@sun.ac.za), Stellenbosch University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 49 / **83**

Stopless removal in the Tile Muon trigger system of the Tile Calorimeter in the ATLAS detector

Author: Humphry Tlou[1]

Co-authors: Bruce Mellado [1]; Henric Wilkens [2]

[1] *University of the Witwatersrand*

[2] *CERN*

ATLAS (A Toroidal LHC Apparatus) is one of the two general-purpose detectors at the Large Hadron Collider (LHC). The Tile Calorimeter (TileCal) is the hadronic calorimeter of the ATLAS experiment, it is made out of iron plates and plastic scintillator. The TileCal is divided into three cylinders along the beam direction, each of which is segmented azimuthally into 64 modules. The photo multiplier tubes (PMTs) and the front-end electronics are located in the super-drawers in the outermost part of the modules.TileCal online software is a set of Trigger and Data Acquisition (TDAQ), and its main purpose is to readout, transport and store physics data originating from collisions at the LHC. The Tile Muon trigger system is part of the trigger system, it is used for the detection of interesting muon events using the outermost radial layers(D5 and D6 cells) of the TileCal system. A special board called "Tile Muon Digitizer Board" (TMDB) is responsible for digitizing the analogue muon trigger output from the D5 and D6 cells. The TMDB is also a Read Out Driver (ROD) that sends outputs to the Read Out System(ROS), just like most RODs and it provides a busy signal to regulate the trigger rate due to bandwidth limitations. The main source of the Level-1 Muon-Trigger background in the end-cap region is low momentum protons emerging from magnets and shielding in the forward region. They produce correlated hits leading to coincidences in the trigger muon chambers up to the highest transverse momentum muon threshold. Requiring a coincidence with some other detectors lying inside the toroid magnets and shielding, lowers the fake event trigger rate. There is always a possibility to result in a permanent busy assertion by the TMDB boards due to hardware or firmware failures. Tile muon trigger system requires functionalities that will aid in detecting changes in conditions of an asserted permanent busy and send the stopless removal (recovery commands) to instruct the TDAQ system to remove the corresponding TMDB. This ensures that the corresponding input is ignored,allowing the triggers to flow again. This contribution discusses in detail the stopless removal software for the TileCal online software.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Bruce Mellado
Bruce.Mellado@wits.ac.za
University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Space Science / **84**

The response of the ionosphere to geomagnetic storms within 20&degE – 40&degE African longitude sector

Author: Tshimangadzo Merline Matamba[1]

Co-author: John Bosco Habarulema [1]

[1] *South African National Space Agency Space Science, Hermanus, South Africa*

Corresponding Author: mtshimangadzo@sansa.org.za

Geomagnetic storms are mainly driven by Coronal Mass Ejections (CMEs) and Co-rotating Interaction Regions (CIRs). In response to the magnetosphere-ionosphere system, different ionospheric storm effects may be observed in mid, low and equatorial latitude regions depending on the driving mechanisms of any particular geomagnetic storm. This work will discuss ionospheric storm effects during both CME and CIR driven storms over the African sector for the period 2000 - 2015. The dependence of ionospheric storm effects on solar activity and some mechanism that influences the ionospheric storm effects are presented.

**Apply to be
 considered for a student
   award (Yes / No)?:**

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

PhD

**Main supervisor (name and email)
and his / her institution:**

Dr John Bosco Habarulema
jhabarulema@sansa.org.za
South African National Space Agency Space Science, Hermanus, South Africa
Department of Physics and Electronics, Rhodes University, Grahamstown, South Africa

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Nuclear, Particle and Radiation Physics 1 / 85

Nuclear level densities and gamma-ray strength functions of <sup>180,181,18 and neutron capture cross sections

Author: Kgashane Malatji[1]

Co-authors: Andreas GöRGEN [2]; Ann-Cecilie Larsen [2]; Bonginkosi Kheswa [3]; Christiaan Brits [1]; Darren Bleuel [4]; Eda Sahin [2]; Fabio Zeiser [2]; Francesca GIACOPPO [5]; Frank BELLO GARROTE [2]; Gry Tveten [2]; Hilde Nyhus [2]; Kasia HADYNSKA-KLEK [6]; Magne GUTTORMSEN [2]; Malin KLINTEFJORD [2]; Mathis Wiedeking [7]; Sunniva Rose [2]; Sunniva Siem [2]; Therese RENSTRøM [2]; Trine HAGEN [2]; Vetle INGEBERG [2]

[1] *SU*

[2] *Department of Physics, University of Oslo, NO-0316 Oslo, Norway*

[3] *UJ*

[4] *Lawrence Livermore National Laboratory, Livermore, California 94551, USA*

[5] *Helmholtz Institute Mainz, 55099 Mainz, Germany and GSI Helmholtzzentrum fur Schwerionenforschung, 64291 Darmstadt, Germany*

[6] *INFN, Laboratori Nazionali di Legnaro Padova, 35020 Legnaro, Italy*

[7] *Department of Subatomic Physics, iThemba LABS, Old Faure Road, 7131, South Africa*

Corresponding Author: kgashanel@gmail.com

Most stable and extremely low abundance proton-rich nuclei with <i>A</i> ˜ 110 are thought to be produced by the photodisintegration of <i>s</i>- and <i>r</i>- process seed nuclei. However, this so-called <i>p</i>-process is insufficient to explain the observed low abundance (0.012%) of the ¹⁸⁰Ta isotope. Hence combinations of several processes are considered to reproduce the observed abundance of ¹⁸⁰Ta in the cosmos, provoking debates and making it a unique case to study. Significant uncertainties in the predicted reaction rates in ^p-nuclei arise due to large uncertainties in nuclear properties such as the nuclear level densities (NLD) and gamma-ray strength functions (γSF) [1], as well as the actual astrophysical environments. An experiment was performed in October 2014 to extract the NLD and γSF in ^{180,181,182}Ta isotopes which provide important input parameters for nuclear reaction models. In the present case study, these parameters were measured using the reactions ¹⁸¹Ta(³He, ⁴He'γ) and ¹⁸¹Ta(³He, αγ) with 34 MeV beam, ¹⁸¹Ta(d, d'γ) and ¹⁸¹Ta(³He, tγ) with 15 MeV beam , and ¹⁸¹Ta(d, d'γ) and ¹⁸¹Ta(d, pγ) with 12.5 MeV beam at the Oslo Cyclotron Laboratory. Using the SiRi array at backward angles (64 silicon particle telescopes) and the CACTUS array (26 NaI(Tl) detectors), the NLD and γSF were simultaneously extracted below the neutron separation energy from particle-γ coincidence matrices through iterative procedures using the Oslo method [2]. The experimental results have been used to determine the corresponding neutron capture cross sections, which in turn were utilized to extract Maxwellian averaged cross sections. The latter can be used in astrophysical network calculations to investigate the galactic production mechanism of 180Ta. In this talk I will present results of this investigation.

[1] S. Goriely et al., A&A J. 375, L35 (2001).
[2] A. Schiller et al., NIM Phys. Res. A 447, 498 (2000).

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Mathis Wiedeking (wiedeking@tlabs.ac.za)
Department of Subatomic Physics, iThemba LABS, Old Faure Road, 7131, South Africa

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Nuclear, Particle and Radiation Physics 2 / 86

Overview of recent results in the diphoton decay channel with pp collisions collected during 2015 and 2016 at 13 TeV with the ATLAS detector

Author: Robert Reed[1]

[1] *University of Witwatersrand*

Corresponding Author: robert.reed@cern.ch

The LHC began Run II operations in the second half of 2015. This is the first physics run since the discovery of the Higgs boson in 2012 and opens the door to new physics beyond the standard model. Recent results based on the 2015 and 2016 data include the measurement of the fiducial, differential and production cross sections of the Standard Model (SM) Higgs boson of mass 125.09 GeV as well as Beyond the SM searches for resonances in the high mass diphoton region. An overview of these recent results will be given.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Main supervisor (name and email)
and his / her institution:**

Bruce Mellado
University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Nuclear, Particle and Radiation Physics 2 / 87

Exploring new physics in events with missing transverse energy and a Higgs boson decaying to two photons with the ATLAS detector

Author: Shell-may Liao[1]

Co-authors: Bruce Mellado [2]; Chuene Mosomane [3]; Deepak Kar [3]; Kehinde Tomiwa [2]; Robert Reed [3]; Stefan von Buddenbrock [2]; Tshidiso Molupe [2]; XIFENG RUAN [4]

[1] *University of the Witwatersrand, School of Physics, 1 Jan Smuts Avenue, Braamfontein, Johannesburg, 2000, South Africa"*

[2] *University of the Witwatersrand*

[3] *University of Witwatersrand*

[4] *WITS*

Corresponding Author: shellmayl@yahoo.com

The results of a search for new phenomena in events with missing transverse energy (MET) and a Higgs boson decaying to two photons are presented. Data from proton-proton collisions at a centre-of-mass energy of 13 TeV, corresponding to an integrated luminosity of 36.1 fb⁻¹ have been collected with the ATLAS detector at the LHC in 2015 and 2016. The results of this search are interpreted in terms of a model in which a heavy scalar, denoted 'H', decays into the Higgs boson and dark matter candidates (H->h&Chi&Chi). A model formulated based on inconsistencies in the Higgs boson transverse momentum distribution (p_{T,H}) measured by ATLAS and CMS as well as other excesses in the data. Limits were placed on the branching ratio of H->h&Chi&Chi using Run II data and the analysis is performed in several categories based on MET and MET significance and splitting into the same vertex method. The results from this search are discussed.

**Apply to be
 considered for a student
   award (Yes / No)?:**

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

PhD

**Main supervisor (name and email)
and his / her institution:**

Professor Bruce Mellado
Bruce.Mellado.Garcia@cern.ch
University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Poster Session 1 - Board: 15 / **88**

On the synthesis and characterization of Tungsten Oxide (WO3) doped with Carbon Nanotubes (CNTs) nanostructures for gas sensing applications

Author: Thokozani Mpanza[1]

Co-authors: Ceboliyazakha Ndlangamandla [1]; Charles Thethwayo [1]; Osman Ndwandwe [1]

[1] *University of Zululand*

Corresponding Author: thokozanimpanza@gmail.com

There is a considerable desire to control and monitor gas emissions from industries like in mining and energy industries where fossil fuels are used to generate electric power. Most gases emitted from these industries are not environmental friendly since they result in air pollutions, acid rains and global warming. Gas sensors have been reported as promising devices to resolve these issues. In this study a DC magnetron sputtering is used to synthesis tungsten oxide (WO3) doped with carbon nanotubes (CNTs) nanostructures on silicon substrates for gas sensing applications. CNTs are grown on top of WO3 nanoparticles for improving gas sensing properties of WO3. Crystallinity and porosity of the sensor material is expected to enhance the sensitivity and selectivity of the fabricated gas sensor. The structural, morphological and composition were investigated using XRD, SEM equipped with EDS. SEM results shows small size (in nanoscale) of WO3 particles evenly distributed on silicon substrate with some small spaces in between which is promising for gas adsorption. EDS results confirmed the WO3 composition. Due to the spacings between these nanoparticles of WO3, it is therefore expected that the gas sensing properties of this material will improve. This is due to the fact that gas will be easily be adsorbed between the nanoparticles.

Summary:

In this study WO3 nanostructures were successfully deposited on silicon<100>/<111> substrates using DC magnetron sputtering. WO3 films were deposited under various substrate temperatures (450 °C, 500 °C, 600 °C and 700 °C) for successful crystallization of WO3 films. These films were then characterized by the SEM equipped with EDS and XRD. The balance crystallinity and porosity properties of WO3 nanoparticles were achieved at 500 °C and due to these properties WO3 is expected to show good gas sensing properties. Gas sensing properties of WO3 will be measured using kinosistec system, and WO3 film is expected to show a good sensitivity and selectivity to NO2 gas. Doping WO3 with CNTs is expected to show good improvement of gas sensing properties of WO3 material.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Dr C.L. Ndlangamandla
NdlangamandlaC@unizulu.ac.za
University of Zululand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Astrophysics / 89

Shell-model calculations of the Cl-34(p,gamma)Ar-35 astrophysical rp reaction rates

Author: Werner Richter[1]

Co-author: Alex Brown [2]

[1] *Stellenbosch University*

[2] *Michigan State University*

The thermonuclear Cl-34(p,gamma)Ar-35 reaction rates are unknown at nova temperatures due to a lack of experimental nuclear physics data for the resonances up to about 800 keV above the Ar-35 proton separation energy. We present results of calculations in a
full (0+1)(h/2π)ω model space using the interaction sdpfmu. The basis consists of a complete 1(h/2π)ω basis made from all possible excitations of one nucleon from 0p
to 1s-0d or the excitation of one nucleon from 1s-0d to 0p-1f. Such calculations were carried out recently for the first time for the P-30(p,gamma)S-31 reaction. We explicitly calculate the rates for transitions from the ground state of Cl-34 as well as from the isomeric first excited state of Cl-34. Spectroscopic factors and proton-decay widths are calculated for input into the reaction rate. Available experimental data are used in conjunction with the calculations to obtain an estimate for the reaction rate. The negative parity states contribute significantly to the total reaction rate, comparable to the positive parity states, both for transitions from the ground state of Cl-34 and the isomeric first excited state. The contributions to the positive parity states from the first excited state of Cl-34 are comparable to those from the ground state. The calculations also serve to identify the most prominent resonances in the reaction rates. The analysis should serve as a guide for experiments as the spin-parity assignments of the most prominent resonances and their relative strengths are given.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Nuclear, Particle and Radiation Physics 1 / 90

New B(2+1| E2 |0+1) value in 20Ne: mitigating an old challenge with rotor model

Author: Senamile Masango[1]

[1] *Student*

Corresponding Author: phatsena1@gmail.com

The highly-efficient and segmented TIGRESS HPGe gamma; array at TRIUMF permits accurate Coulomb-excitation studies of the high-lying 2+1 states found in light nuclei with even number of protons and neutrons. A Coulomb-excitation measurement of 20Ne projectiles at safe energies has been carried out with the 110Pd(20Ne,20Ne)110Pd reaction at 64.7 MeV. A larger reduced transition probability of B(E2; 2+1 to 0+1) = 26:5 plus or minus 1:7 W.u. has been determined in disagreement with the accepted value and mean-field calculations. This larger B(E2; 2+1 to 0+1) mitigates, however,previous discrepancies with the rotational model of Bohr and Mottelson.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc,

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 39 / **91**

The influence of neutron radiation damage on the optical properties of polystyrene based scintillator UPS 923A

Author: Skhathisomusa Mthembu[1]

[1] *University of the Witwatersrand*

Corresponding Author: sktbolt@gmail.com

Plastic scintillators are vital in the reconstruction of hadronic particle energy and tracks resulting from the collision of high energy particles in the Large Hadron Collider (LHC) at CERN. These plastic scintillators are exposed to harsh radiation environments and are susceptible to radiation damage. The effects of radiation damage on the transmittance, luminescence and light yield of polystyrene-based scintillator UPS-923A are studied at higher fluences, with the possibility of comparison with other new radiation hard materials. Samples are irradiated with fast neutrons, of varying energies and fluences, using the IBR- 2 reactor FLNP (Frank Laboratory of Nuclear Problems) at the Joint Institute for Nuclear Research. Results show the effect of neutron irradiation damage on the plastics, and their relative radiation hardness.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Bruce Mellado
Bruce.Mellado@wits.ac.za
University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Nuclear, Particle and Radiation Physics 2 / **92**

Reconstruction of missing energy in event with two photons in ATLAS detector at the Large hadron collider.

Author: Kehinde Tomiwa[1]

Co-authors: Bruce Mellado [1]; Shell-may Liao [2]; XIFENG RUAN [3]

[1] *University of the Witwatersrand*

[2] *University of the Witwatersrand, School of Physics, 1 Jan Smuts Avenue, Braamfontein, Johannesburg, 2000, South Africa"*

[3] *WITS*

Corresponding Author: kehinde.tomiwa4@gmail.com

The missing transverse momentum in the ATLAS experiment is the momentum imbalance in the plane transverse to the beam axis. That is the resultant of the negative vectorial sum of the momenta of all particles that are involved in the proton-proton collision. A precise measurement of the missing transverse energy is essential for many physics studies at the LHC, such as Higgs boson measurements, as well as for searches of physics beyond the Standard Model. The reconstruction of missing energy is sensitive to the presence of additional collisions, usually referred to as pile-up. A new method is being used to reduce the effect of pileup events in ATLAS experiment. This presentation describes the performance of missing energy in respect to the improvement of vertex methods in ATLAS experiment.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Bruce Mellado <Bruce.Mellado@wits.ac.za> / University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 50 / **93**

Energy scale validation and inter calibration of the ATLAS TileCal using 2015 and 2016 cosmic rays data

Author: Kehinde Tomiwa[1]

Co-authors: Bruce Mellado [1]; Pawel Jan Klimek [2]

[1] *University of the Witwatersrand*

[2] *CERN*

Corresponding Author: kehinde.tomiwa4@gmail.com

The ATLAS experiment records data from the proton-proton collisions produced by the Large Hadron Collider (LHC). The Tile Calorimeter is the hadronic sampling calorimeter of ATLAS in the region $|\eta| < 1.7$. It uses iron absorbers and scintillators as the active material. Cosmic ray data are used to validate the energy scale and inter-calibration between different layers and regions of the Tile calorimeter. The cosmic data collected in 2015-2017 are used in this study.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Bruce Mellado <Bruce.Mellado@wits.ac.za>

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 40 / **94**

The effects of space weather and the solar cycle on the South African climate

Author: Renier Hough[1]

Co-authors: Du Toit Strauss [2]; Phillip Prinsloo [3]

[1] *North-West University*

[2] *Centre for Space Research, North-West University*

[3] *North-west University*

Corresponding Author: renierht@gmail.com

In this research project, aspects of the cosmoclimatology theory are tested for a South African context. It has been suggested that cosmic rays may contribute to the production of condensation nuclei that are needed for cloud formation. To test this, since cloud production could have an effect on temperature, rainfall, and hours of daily sunlight, the periodicities in these locally measured quantities are analyzed. These periodicities are compared to those found in sunspot numbers, local neutron monitor counts, and total solar irradiance, as indicators of space weather and the solar cycle. Lastly, it is determined whether a linear correlation exists between these climate and space weather indicators. This should provide some estimate of the importance of space weather in changes of local climate conditions.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Hons

**Main supervisor (name and email)
and his / her institution**:

Dr. R.D. Strauss
dutoit.strauss@gmail.com
North-West University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 51 / **95**

NMISA Radioactivity services for industry

Author: Milton van Rooy[1]

Co-authors: Joline Lubbe [1]; Martin van Staden [2]

[1] *NMISA*

[2] *National Metrology Institute of South Africa*

Corresponding Author: mvrooy@nmisa.org

The Radioactivity Standards (RS) Section of the National Metrology Institute of South Africa (NMISA) provides traceability to the national measurement standard for radioactivity through various services offered to the nuclear industry. Services are mainly performed through our calibrated secondary instruments comprised of an ionization chamber, a High-Purity Germanium (HPGe) detector and a commercial liquid scintillation counter. With these instruments, activity measurements of radionuclides in various geometries of liquid or solid form can be performed, with typical uncertainties between 1 % and 10 %. We also provide primary measurement services with greater accuracy and smaller uncertainty. A summary of these services is provided.

Ionization chamber measurements are mostly employed for the nuclear medicine industry where accurate activity measurements of radionuclides used for calibrations/diagnostics/treatment is required. These radionuclides include I-131, Mo-99, Tc-99m, F-18, Ga-67, Co-57, Fe-59, Cs-137 and Lu-177. Using radioactive standards, hospital dose calibrator performance checks can also be performed at hospitals and new calibration factors determined if required. Calibration factors in various geometries can also be determined.

Low level activity measurements of environmental samples are performed via gamma-ray spectroscopy with the HPGe detector. Samples are most commonly analysed for the following radionuclides: Co-60, Cs-134, Cs-137 (in milk, water, black mussels/ fish, green leafy vegetables, grass, soil, sediment and sewage) and I-131 in milk. The HPGe detector is also used to measure radioactivity in consumer products.

Low level beta and alpha emission is measured with the commercial liquid scintillation counter, primarily pure beta-emitters such as H-3 in fresh surface water, C-14 and Sr-90 in milk.

In addition, radioactive sources (for detector calibration or experiments) can be prepared in various geometries such as point sources, Marinelli beakers and ampoules, through accurate weighing.

Through our primary measurement techniques known as $4\pi\beta\gamma$ coincidence counting and the triple-to-double coincidence ratio (TDCR) method we can perform high accuracy and high precision measurements with small uncertainties, usually below 1 %.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Theoretical and Computational Physics 1 / 96

Rapidity evolution of observables at high energies using the gaussian truncation

Author: Daniel Adamiak[1]

Co-author: Heribert Weigert [1]

[1] *University of Cape Town*

Corresponding Author: daniel.m.adamiak@gmail.com

Today, the biggest predictive uncertainties in the standard model arise from theoretical uncertainties in quantum-chromo-dynamics contributions to cross-sections measured at high-energy collider experiments. At high energies, the quantum-chromo-dynamics of particle collisions is well described through the use of the colour-glass condensate. In this domain, the interaction of coloured objects with the CGC medium is well explained through the use of path-ordered colour rotations, called Wilson Lines, as well as their correlators. The rapidity evolution of these correlators is given by the JIMWLK equation. However, this leads to an infinite hierarchy of coupled differential equations, which are impossible to solve in a closed form and truncations become necessary. The most common truncation relies on the large Nc limit, which is relatively crude and subtly breaks gauge invariance. To get around this, we can perform a gauge invariant truncation of this hierarchy in the form of the gaussian truncation for the correlators of these Wilson lines. Initial comparison to HERA data for the total and rapidity gap cross-sections show a noticeable improvement in comparison to data which only depend on the dipole correlator. We extend this method to incorporate observables that depend on more complicated correlators and present the machinery for how to compute their rapidity dependence with the gaussian truncation.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Associate Professor Heribert Weigert
heribert.weigert@uct.ac.za
University of Cape Town

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 16 / **97**

Atomistic simulation studies of Lithium intercalation into amorphous structure of TiO2 nanoporous

Author: Malili Matshaba[1]

Co-author: Phuti Ngoepe [1]

[1] *University of Limpopo*

Corresponding Author: malili.matshaba@ul.ac.za

Due to its wide band gap Titanium dioxide (TiO_2) has variety of applications such as photo-catalysis, dye sensitized, energy storage, etc. In this work amorphous nanoporous structure of TiO_2 consisting of 15 972 atoms has been generated and lithiated with different concentration of Lithium atoms for Lithium ion batteries (LIB). Amorphisation and re-crystallisation technique was employed to attain Li-TiO_2 nanoporous and its microstructures. Molecular dynamics simulation has been performed to crystallise all intercalated nanoporous using the computer code DL_Poly. Lithiated nanoporous structures was annealed to 0 K. Microstructures reveal Li atoms on the surface entrance sites and on channel of the structure, which makes the material a good anode material for LIB. It also indicate that nanoporous can store and transport Li atoms during charging and discharging. X-ray diffractions indicate that our system has brookite and rutile phases which accord well with the experimental data.

**Apply to be
 considered for a student
   award (Yes / No)?**:

no

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

n/a

**Main supervisor (name and email)
and his / her institution**:

Malili Matshaba
malili.matshaba@ul.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Poster Session 2 - Board: 40 / **98**

CHARACTERIZATION OF URANIUM-THORIUM WASTE

Author: Phathutshedzo Murovhi[1]

Co-authors: Ncholu Manyala [2]; Rasimati Mavunda [1]

[1] *NECSA*

[2] *UP*

Declaration of uranium and thorium isotopic content is of utmost importance in safeguard and IAEA agency including the uranium enrichment. Gamma spectroscopy is currently the most preferred methodology in safeguards due to none destructive nature. Historical 360 L drums that cannot be characterized using the IQ-3 drum scanner have become a challenge not only by size but also by density, and weight. ISOCS (In Situ Objective Counting System) has profoundly become the only solution; however, what is the total uncertainty of the measurements? With application of gamma spectroscopy what is the uncertainty distribution? What version of MGA-U can offer reliable enrichment data for such combination of vital safeguarded materials?
Keywords: Uranium, Thorium, Safeguards, IAEA, Gamma spectroscopy, ISOCS, MGA-U

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

no

Applied Physics / **99**

Trigger and Data Acquisition systems readout architecture of the Tile PreProcessor Demonstrator for the ATLAS Tile Calorimeter phase-II upgrades.

Author: Dingane Hlaluku[1]

Co-authors: Alberto Valero [2]; Fernando Carrio [3]

[1] *Student*

[2] *Instituto de Fisica Corpuscular (UV-CSIC)*

[3] *University of Valencia / CERN*

Corresponding Author: d.hlaluku@cern.ch

The LHC has planned a series of upgrades culminating in the High Luminosity LHC (HL-LHC) which will have an average luminosity 5-7 times larger than the nominal Run-2 value. The ATLAS Tile Calorimeter (TileCal) will undergo an upgrade (phase-II) to accommodate the HL-LHC parameters. The TileCal both on and off-detector electronics will be completely redesigned and a new Trigger and Data Acquisition (TDAQ) system readout architecture will be adopted for this upgrades. With this new readout strategy, the front-end electronics will transmit readout data for every bunch crossing (25 ns) to the first element of the back-end electronics viz. the Tile PreProcessors (TilePPr). The TilePPr is a high-performance double AMC board based on FPGA resources and QSFP modules. This board has been designed in the framework of the ATLAS TileCal Demonstrator project for the phase-II upgrades as the first stage for the back-end electronics. The TilePPr will provide an interface path for the readout, configuration, control and monitoring of the front-end electronics, and will send calibrated information to the ATLAS Level 0 trigger system for trigger decision. A single TileCal drawer module commissioned with the phase-II upgrade electronics is to be inserted into the real detector to evaluate and qualify the new readout and trigger concepts in the overall ATLAS TDAQ system.This new drawer, so-called Hybrid Demonstrator, must provide an analog trigger signal for backward compatibility with the current system. This Demonstrator drawer has been inserted into a TileCal module prototype to evaluate the performance in the lab. In parallel, one more TileCal module has been instrumented with two other front-end electronics options based on custom ASICs (QIE and FATALIC) which are under evaluation. These two modules equipped with the Phase-II upgrade electronics together with three other modules instrumented with the current system electronics were exposed to different particles and energies in three test-beam campaigns during 2015 and 2016.This contribution will describe in detail the various components of the TDAQ infrastructure of the upgrade specific electronics, and some preliminary results from the test beam campaigns.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof. Bruce Mellado
Bruce.Mellado@wits.ac.za
University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Space Science / 100

Geomagnetic Storm Impact on HF Communications and Radiation Exposure at Aviation Altitude

Author: Rendani nndanganeni[1]

Co-authors: Michael Kosch [2]; Mpho Tshisaphungo [3]

[1] *South African Nation Space Agency*

[2] *SANSA*

[3] *Department of Physics & Electronics, Rhodes University , Grahamstown, 6140, South Africa; South African National Space Agency (SANSA) Space Science, Hermanus, 7200, South Africa*

Corresponding Author: rnndanganeni@sansa.org.za

Geomagnetic storms are one of the space weather events that have an impact on HF communications and can also contribute in enhancing the radiation exposure at aviation altitude. This paper presents the analysis of moderate geomagnetic storm activity of the period 7-9 March 2012 and 16-19 March 2015. The impact on HF propagation parameter foF2 and radiation dose rate is analysed to quantify the magnitude of the impact during these storm periods. Ionospheric foF2 data measured by ionosonde from Grahamstown station (33.3 S, 26.5 E) was used in the analysis. The monthly median of foF2 values was calculated to indicate the quiet day-to-day variation of foF2. To evaluate the level of radiation exposure over different routes the MAIRE model is used to generate the radiation dose rate data. Results show that during the storm day of 9 March 2012 a decrease in foF2 values (negative ionospheric storm) was observed, whereas during the storm day of 17 March 2015 an increase in foF2 values (positive ionospheric storm) was observed. This results show that an HF communications is expected to be disturbed by +/- 2 MHz during a moderate geomagnetic storm. An enhancement in radiation dose rate was also observed as compared to the quiet days during both storm periods.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Nuclear, Particle and Radiation Physics 2 / 101

Exotic searches with jet substructure at the LHC

Author: Debarati Roy[1]

[1] *Postdoc at Wits*

Corresponding Author: debarati.roy@cern.ch

Increase energy in LHC drives us to perform exotic searches in the kinematic regions unreachable before. Being a hadron collider it is utterly important to explore the LHC physics with the detailed understanding of the performance of jets, direct manifestations of hadrons as produced in significant number from proton proton interactions. It is most likely that newly reached higher energy can result in such energetic (boosted) objects that decay further into products collimated in a single large radius jet (fatjet) with some definite structure (jet substructure). Jet substructure study describes the distinctive nature of this type of jet (e.g. as observed from boosted top quarks) from the jets coming out of partons (quarks and gluons) and is currently used as one of the primary tools in extensive number of exotic searches of heavy particles decay in LHC. This contribution will briefly talked about some of the recent searches in LHC where jet substructure study plays a significant role.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Poster Session 1 - Board: 52 / **102**

Generation of hyper-entangled photon states for quantum key distribution

Authors: Anesan Reddy[1]; Shamik Maharaj[1]

Co-authors: Francesco Petruccione [2]; Yaseera Ismail [2]

[1] *University of KwaZulu-Natal*

[2] *UKZN*

Corresponding Author: yaseera.ismail064@gmail.com

Quantum entanglement is a phenomenon that occurs when the states of individual particles become linked to one another. Thus, performing a measurement on one particle has an immediate effect on its entangled partner/s, irrespective of the distance between the particles. In this experiment, pairs of entangled photons are produced by spontaneous parametric down conversion. The quality of entanglement is verified by performing measurements on the entangled photon states. The measured states should violate the Bell inequality which would be conclusive verification that the photons are entangled [1]. Encoding photons through polarisation coupled to high-dimensional spatial modes allows for the generation of hyper-entangled states [2]. Higher-dimensional spatial modes is experimentally generated using liquid crystal technology. Quantum entanglement enhances the security of the quantum key distribution process. Hyper-entangled states promotes secure data transfer over the quantum channel.
Here, we present the experimental verification of entanglement and the creation of higher dimensional states for quantum communication.

Reference
[1] J. Clauser, R. Holt, M. Horne and A. Shimony, "Proposed Experiment to Test Local Hidden-Variable Theories," Phys. Rev. Lett., 23(15), 880-884 (1969).
[2] J. T. Barreiro, N. K. Langford, N. A. Peters, and P. G. Kwiat, "Hyper-Entangled Photons," in Frontiers in Optics, OSA Technical Digest Series (Optical Society of America, 2005), paper LMB3

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Hons

**Main supervisor (name and email)
and his / her institution**:

Prof Francesco Petruccione
petruccione@ukzn.ac.za
University of KwaZulu-Natal

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Photonics / **103**

An application of optical tweezers in the measurement of picoNewton forces

Author: Anneke Erasmus[1]

[1] *Stellenbosch University*

Optical tweezing is an established technique that has been developed for manipulating micron sized objects. These applications include cell sorting, studying intracellular dynamics, applying specific forces to trapped particles as well as quantitative measurement of intracellular forces, for example measuring the force exerted by molecular motors inside a living cell. Trapping occurs when the light is tightly focused with a high numerical aperture objective lens onto the object of interest. This technique makes it possible to remotely investigate mechanical properties of a sample. This work focuses on the application of the optical tweezers in force measurements using a custom optical tweezers setup built to be integrated into a nonlinear microscopy setup. This presentation discusses the construction of the tweezers setup, the calibration processes and force measurement studies. A diode laser (975 nm) is used to trap micron sized silica particles. Calibration of the force constant of the optical tweezers setup was done using silica beads and a quadrant position detector. Preliminary results in determining the forces exerted by myosin motor proteins pulling vesicles along actin filaments inside an onion (Allium cepa L.) cell will be presented and discussed.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof EG Rohwer
egr@sun.ac.za
Stellenbosch University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Applied Physics / 104

Temporal two-photon interference of entangled photons generated using partially coherent pump beam

Author: Stuti Joshi[1]

Co-authors: Francesco Petruccione [1]; Yaseera Ismail [1]

[1] *University of KwaZulu-Natal*

Corresponding Author: joshis@ukzn.ac.za

Two-photon interference effects of entangled photons produced by spontaneous parametric down-conversion (SPDC) received a lot of attention in the last few decades. Various kinds of two-photon interference effects such as Hong-Ou-Mandel (HOM) effect, two-photon fringes in a Franson interferometer, induced coherence without induced emission, frustrated two-photon creation, and post-poned compensation has been observed by different groups [1-3]. Previous studies have considered the pump beam as spatially coherent. It has been proven that in many applications a partially coherent beam is more robust than the fully coherent one. Recently, Jha and Boyd showed theoretically that the spatial coherence properties of the pump beam are entirely transferred to the coherence

properties of the down-converted fields [4]. Of late it has been shown that the detection probability of the entangled two-photon field is higher and less susceptible to change in the properties of the environment if the field is produced by a lower mode of partially coherent pump beam [5].

Here, we present the results of our experimental work on temporal two-photon interference by considering pump beam as partially spatially coherent. For this, we used HOM-like interferometer which is based on the mixing of signal and idler photons. HOM-like effects can be understood as observations of how the degree of two-photon coherence changes as a function of the biphoton path-asymmetry-length difference.

References:
[1] C. K. Hong, Z. Y. Ou, and L. Mandel, Phys. Rev. Lett. 59, 2044 (1987).
[2] P. G. Kwiat, A. M. Steinberg, and R. Y. Chiao, Phys. Rev. A 47, R2472 (1993).
[3] T. B. Pittman et al., Phys. Rev. Lett. 77, 1917 (1996).
[4] A K Jha and R. W. Boyd, Phys. Rev. A, 81, 013828 (2010).
[5] Y. Qiu and W. She, Appl Phys B 108:683–687 (2012).

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Prof. Francesco Petruccione,
petruccione@ukzn.ac.za
University of KwaZulu-Natal (Westville Campus)

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Applied Physics / **105**

Two-photon polarisation entangled states using partially spatially coherent pump beam

Author: Yaseera Ismail[1]

Co-authors: Francesco Petruccione [2]; STUTI JOSHI [3]

[1] *University of KwaZulu-Natal*

[2] *UKZN*

[3] *UNIVERSITY OF KWAZULU-NATAL, WESTVILLE CAMPUS, DURBAN, SOUTH AFRICA*

Thus far the development of entangled photon sources is based on the use of a fully coherent pump beam through a process of spontaneous parametric down conversion (SCPD). Of recent, there has been numerous theoretical studies based on the temporal and spatial coherence properties of the twin beam state [1]. In particular, for its relevance in the field of quantum information processing and communication. It has been shown that the spatial-spectral and spatial-temporal properties of the entangled photons are affected by crystal and pump beam parameters [2]. Previous experiments considered the pump beam to be spatially coherent however it has been shown theoretically, that the spatial coherence properties of the pump field is entirely transferred to the spatial coherence properties of the down-converted two-photon field [3]. It has also shown that the entanglement of a spatial two-qubit state is affected by the spatial coherence properties of the two photon field [3].
Here we present, the spatial coherence properties of the entangled-photon pairs produced by SPDC. The experimentally produced entangled photons are investigated by taking into consideration the

partial spatial coherence of the pump beam. For spatial correlation in SPDC, coincidence counts are recorded as a function of the detectors. These two photon states are significant for the application of quantum communication.

Reference
1. A. Joobeur, B. E. A. Saleh and M. C. Teich, "Spatiotemporal coherence properties of entangled light beams generated by parametric down-conversion," Phys. Rev. A 50(4), 3349-3363 (1994).
2. K. Jha and R.W. Boyd. "Spatial two-photon coherence of the entangled field produced by down-conversion using a partially spatially coherent pump beam," Phys. Rev. A 81, 013828 (2012).
3. E. A. Saleh, A. F. Abouraddy, A.V. Sergienko, and M. C. Teich, "Duality between partial coherence and partial entanglement," Phys. Rev. A 62, 043816 (2000).

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Prof. Francesco Petruccione
petruccione@ukzn.ac.za
University of KwaZulu-Natal

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Physics Education / 106

What is mathematics good for anyway?

Author: Charlotte Hillebrand-Viljoen[1]

Co-author: Spencer Wheaton [2]

[1] *University of Cape Town*

[2] *Department of Physics*

Corresponding Author: c.s.hillebrand@gmail.com

A course in intermediate mathematics, including linear algebra, is usually a corequisite for an intermediate level physics course and linear algebra is generally considered an important tool for physicists. However, students often struggle both with understanding linear algebra in the abstract (in maths class) and with applying linear algebra concepts to physics.
We present a description, based on Grounded Theory, of student and expert perspectives on linear algebra and its applications in quantum mechanics. This is a multidimensional picture involving not only students' and experts' aptitude with linear algebra and quantum mechanics, but also their strategies for applying one to the other and their subjective attitudes towards how useful and usable the topics in question are.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Dr Spencer Wheaton, UCT
spencer.wheaton@uct.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Nuclear, Particle and Radiation Physics 1 / 107

Calculation of the Energy Produced from Radiative Capture in the SAFARI-1 Nuclear Reactor

Author: Linina Jurbandam[1]

Co-author: Oscar. M Zamonsky [2]

[1] *University of Witwatersrand*

[2] *NECSA*

Corresponding Author: linina100@gmail.com

The knowledge of the fission Q-value is important for the safety analysis of a nuclear reactor. It is around 200MeV/fission in all nuclear reactors, being the energy released from radiative capture (QΥc), the main source of differences between reactors. In this work, we present a detailed calculation of QΥc produced in SAFARI-1 using the MCNP-5 (Monte Carlo N-Particle) code. MCNP is a probabilistic transport code that has the capability of solving general geometries with continuous energy data. In particular, we calculate the reaction rate of the nuclides that contribute majorly to the heating in the SAFARI-1 core. From the nuclear reaction rate and the energy released per reaction (binding energy), the total energy produced from radiative capture was calculated. In previous work, the radiative capture energy was calculated as an energy deposition using MCNP-5. From the energy deposition calculation, QΥc was calculated as 5.42MeV/fission. Using the energy production method, QΥc was calculated as 6MeV/fission. Typical values for QΥc range between 3-12MeV/fission. This work takes a closer look at how to arrive at these values using the two methods in MCNP-5.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Dr O. M. Zamonsky- oscar.zamonsky@necsa.co.za
NECSA- South African Nuclear Energy Corporation

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Applied Physics / 108

Development of Post-Processing Technique for a Quantum Key Distribution System

Author: Marie Louise Umuhire[1]

Co-authors: Francesco Petruccione [2]; Yaseera Ismail [2]

[1] *University of Kwazulu-Natal, Private Bag X54001, Durban 4000, South Africa*

[2] *UKZN*

Corresponding Author: ulouizia@gmail.com

Classical Cryptography offers different methods to encrypt messages amongst authorized users by applying some mathematical techniques which require the users to have shared some information initially[1]. These mathematical techniques can be broken as they all rely on the computational complexity[1]. Quantum Key Distribution (QKD) is an alternative means of encrypting information whereby instead of users exchanging an encrypted message; they share first the symmetric-key[2]. QKD relies on the properties of Quantum Mechanics to protect the information transfer from the interference of an eavesdropper. The implementation of QKD demands an appropriate protocol which can enable the users to produce a secure key.
Apart from the key distribution process, post-processing is performed to obtain a final key. This is achieved through an error reconciliation protocol. Post-processing is required to eliminate errors introduced by an eavesdropper in the quantum channel and imperfections of the equipment used[3]. The error reconciliation protocol is hence needed to identify and fix all the errors in the shared key, so that at the end users will have the same identical key.
In this research, the data used for post-processing were obtained from experimental implementation of the Coherent One-Way (COW) protocol using free space as a quantum channel. We applied Cascade error reconciliation protocol to the raw key obtained in the experiment to identify and fix errors obtained in the quantum transmission process. Also Cascade error reconciliation protocol is tested to verify how efficiency of the system.

References

1.Zoller, P., et al., Quantum information processing and communication. The European Physical Journal D-Atomic, Molecular, Optical and Plasma Physics, 2005. 36(2): p. 203-228.

2.Nicolas, G., et al., Quantum cryptography. REVIEWS OF MODERN PHYSICS, 2002. 74(1): p. 145 - 195.

3.Brassard, G. and L. Salvail. Secret-key reconciliation by public discussion. in Workshop on the Theory and Application of of Cryptographic Techniques. 1993. Springer.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof. Francesco Petruccione
petruccione@ukzn.ac.za

University of Kwazulu-Natal.

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 53 / **109**

Modulating Information onto Laser Beams

Author: Mitchell Cox[1]

[1] *University of the Witwatersrand*

Corresponding Author: mitch@enox.co.za

Mode Division Multiplexing (MDM) is an emerging technology which harnesses the spatial degree of freedom of laser beams to significantly increase the overall capacity of optical communication systems. MDM research is typically carried out using cameras to measure the beam characteristics under various conditions. In high speed digital communication systems, the time domain characteristics of the beam and of the information modulated onto the beams is important, and it is not possible to use existing, camera-based experimental techniques to thoroughly investigate these characteristics. In this presentation, experimental techniques using so-called "radio over optical" will be described along with explanations for how the data may be interpreted to derive useful physical channel characteristics.

Summary:

Mode Division Multiplexing (MDM) is an emerging technology which harnesses the spatial degree of freedom of laser beams to significantly increase the overall capacity of optical communication systems. MDM research is typically carried out using cameras to measure the beam characteristics under various conditions. In high speed digital communication systems, the time domain characteristics of the beam and of the information modulated onto the beams is important, and it is not possible to use existing, camera-based experimental techniques to thoroughly investigate these characteristics. In this presentation, experimental techniques using so-called "radio over optical" will be described along with explanations for how the data may be interpreted to derive useful physical channel characteristics.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Andrew Forbes, Wits, andrew.forbes@wits.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Photonics / 110

Mode Division Multiplexing mixing Different Orthogonal Bases

Author: Mitchell Cox[1]

Co-authors: Andrew Forbes [2]; Carmelo Rosales-Guzman [3]

[1] *University of the Witwatersrand*

[2] *CSIR*

[3] *University of the Witwatersrand, Johannesburg*

Corresponding Author: mitch@enox.co.za

Mode Division Multiplexing (MDM) is an emerging technology which harnesses the spatial degree of freedom of laser beams to significantly increase the overall capacity of optical communication systems. Current research typically focusses on the use of Orbital Angular Momentum (OAM), however, MDM research has also been done into the use of orthogonal Laguerre-Gaussian (LG) or Hermite-Gaussian (HG) modes, which have two transverse degrees of freedom. In this work, orthogonal combinations of LG and HG modes are used for MDM as well as a novel application for increasing the resilience of free-space MDM links.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Andrew Forbes, Wits, andrew.forbes@wits.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

no

Poster Session 1 - Board: 17 / **111**

The energy transfer between Gadolinium (Gd3+) ion and Cerium (Ce3+) ion

Author: Thabang Johannes Nkosi[1]

[1] *University of Johannesburg*

Corresponding Author: nkosithabang@gmail.com

The series of Ca3(PO4)2 powder with Gd3+ ion were synthesized using combustion method. The powder phosphor has two sets which are as prepared (at 600±250C) and annealed (1000±50C). The concentration of the Gd3+ ion was varied from 0.0 to 7.0 mol %. The characterization techniques used are X-ray diffraction (XRD), photoluminescence (PL), Ultra-violet visible spectroscopy (UV-Vis), X-ray photoelectron spectroscopy (XPS), Scanning electron microscopy and Energy X-ray Dispersive Spectroscopy(SEM-EDS). XRD was used to confirm Ca3(PO4)2 is rhombohedral structure. PL shows when Ca3-x(PO4)2: xGd3+ excited 274 nm and it emit at 313nm (narrow band for phototherapy use). The EDS confirm the present of elements in the samples. The particle morphologies of the series of Ca3(PO4)2 phosphors were investigated by using the SEM. The possible application will be mercury free lamp for phototherapy.

**Apply to be
 considered for a student
   award (Yes / No)?**:

YES

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Martin Ntwaeaborwa
ntwaeab@gmail.com
University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

N

Theoretical and Computational Physics 1 / 112

Matrix logarithmic quantum wave equation

Authors: Konstantin Zloshchastiev[1]; Miloslav Znojil[2]

[1] *Durban University of Technology*

[2] *Institute of Nuclear Physics CAS, Prague*

Corresponding Author: bozons@gmail.com

Logarithmic quantum wave equation (LogSE) is the nonlinear equation, which possesses unique features that lead to its fruitful applications in different branches of physics - from nuclear physics and condensed-matter theory to particle physics, theory of quantum gravity and models of physical vacuum. Here we proceed with a natural generalization, matrix LogSE, which can be used in a theory of multi-channel quantum processes. We demonstrate exact solutions derived so far and discuss their physical meaning.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Poster Session 1 - Board: 84 / **113**

The effect of annealing temperature on morphology and structural properties of TiO2 nanotubes membranes.

Author: Mpheleki Lupiwana[1]

Co-authors: David Katwire [2]; Edson Meyer [3]; Raymond Taziwa [3]

[1] *University of Fort Hare*

[2] *Chemistry department, University of Fort Hare, Private Bag X1314, Alice, 5700, Republic of South Africa*

[3] *Fort Hare Institute of Technology (FHIT), University of Fort Hare, Private Bag X1314, Alice, 5700, Republic of South Africa*

Corresponding Author: mphelekilupiwana@gmail.com

Abstract
In this work, we present a simple electrochemical approach to obtain large-area free-standing TiO2 nanotube (TNT) membranes, via anodic oxidation of pure Ti metal sheets. The highly ordered vertically oriented TNTs were characterized by SEM-EDS, XRD, CRM and AFM. SEM-EDS analysis confirms the presence of Ti and O-species in the as-prepared free-standing TNTs layer in significant amount. CRM has confirmed the presence of only Anatase phase TiO2 with Raman vibration modes at 144.37 cm-1, 199.04 cm-1, 399.67 cm-1, 516.16 cm-1 and 639.29 cm-1. The intensity of XRD peaks increases with the increase in heat treatment and better crystallinity occurs at higher temperatures. SEM and AFM analysis has revealed the presence of porous structure on the fabricated membranes. The study focused on the effect of annealing temperature on TNTs crystalline structure. Results showed that smooth surface and high aspect ratio TNTs were successfully fabricated.

**Apply to be
 considered for a student
   award (Yes / No)?:**

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof Edson Meyer
EMeyer@ufh.ac.za
University of Fort Hare, Fort Hare Institute of Technology

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Y

Poster Session 2 - Board: 57 / **114**

Energy–efficient Bessel beams

Author: Nokwazi Purity Mphuthi[1]

Co-authors: Andrew Forbes [2]; Roelf Botha [3]

[1] *Hartebeesthoek Radio Astronomy Observatory: Space Geodesy*

[2] *CSIR*

[3] *HartRAO*

Corresponding Author: nokwazi@hartrao.ac.za

Due to their novel properties, Bessel beams have found interesting applications in the fields of metrology, imaging, non-linear optics, micromanipulation, atom guiding and beam shaping for coronagraphs. Their main drawback is in energy losses encountered during propagation, which therefore can limit their usage for long distance applications. In this work, we investigate the energy efficiencies of the different holographic methods used to generate Bessel beams using a Spatial Light Modulator (SLM). These methods will range from using a single holographic mask to using multiple phase masks in order to spread the power over the whole SLM. We will also outline the possible application of Bessel beams in sending pulsed lasers to retroreflectors to the Moon with the aim of accurately determining the Earth-Moon distance; a technique referred to as Lunar Laser Ranging

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof Andrew Forbes
andrew.forbes@wits.ac.za
University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 18 / **115**

Structural, morphological and Raman scattering studies of carbon doped ZnO nanoparticles fabricated by pneumatic spray pyrolysis technique

Author: Luyolo Ntozakhe[1]

Co-authors: Katwire David [2]; Meyer Edson [3]; Taziwa Raymond [4]

[1] *University of Fort Hare*

[2] *Chemistry department, University of Fort Hare, Private Bag X1314, Alice, 5700, Republic of South Africa.*

[3] *Fort Hare Institute of Technology (FHIT), University of Fort Hare, Private Bag X1314, Alice, 5700, Republic of South Africa.*

[4] *Fort Hare Institute of Technology (FHIT), University of Fort Hare, Private Bag X1314, Alice, 5700, Republic of South Africa. Chemistry department, University of Fort Hare, Private Bag X1314, Alice, 5700, Republic of South Africa.*

Corresponding Author: lntozakhe@gmail.com

Abstract

Zinc oxide (ZnO) nanoparticles (NPs) were prepared by pneumatic spray pyrolysis technique (PSP) using zinc ethoxide as a precursor and tetrabutylammonium as a dopant. The morphological, structural and optical properties of PSP synthesized un-doped and C-ZnO NPs were evaluated using SEM, XRD, HRTEM, RS and UV-vis spectroscopy. SEM analysis has revealed that as synthesized NPs have spherical shape and the morphology of the NPs change as the concentration of carbon increases. XRD analysis has revealed peaks at 31.90°, 34.50°, 36.34°, 47.73°, 56.88°, 63.04°, 68.20°, and 77.33° belonging to the hexagonal Wurtzite ZnO crystal structure. HRTEM analysis has revealed the presence of spherical NPs with a NP size of (8.65 nm), (10.11 nm), (12.38 nm) and (13.79 nm) for the un-doped ZnO, 0.01 M C-ZnO 0.015 M C-ZnO, and 0.025 M C-ZnO NPs respectively. Moreover the Selected area diffraction images displaying the fact that only the diffraction planes of (101), (002) and (100) are responsible for the diffraction pattern. RS analysis has shown prominent peaks at 434 cm-1 which is the characteristic peak of E_2ˆ2 (high) mode of the Wurtzite ZnO and the E_2ˆ((2)) (high) has been red shifted by 4 cm-1, as compared to that found in the bulk ZnO. Raman phono shifts in C-ZnO NPs are discussed in detail. The obtained results can be used for identification of phonons in Raman spectra of C-ZnO NPs.

**Apply to be
 considered for a student
   award (Yes / No)?:**

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

MSc

**Main supervisor (name and email)
and his / her institution:**

Prof Edson Meyer
EMeyer@ufh.ac.za
University of Fort Hare, Fort Hare Institute of Technology

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Applied Physics / 116

The proposed system improvements of the hydrometer calibration using the Cuckow's method at NMISA

Author: Bongani Ndlovu[1]

Co-authors: Daniel Jabulane Mabena [1]; Ramaite Thomas Mautjana [2]

[1] *National Metrology Institute of South Africa (NMISA)*

[2] *NMISA and University of Limpopo*

Hydrometers are instruments that are used for measuring the density or specific gravity of liquids. NMISA uses the Cuckow's method which is based on hydrostatic weighing to calibrate hydrometers. This involves weighing the dry hydrometer in air and then in liquid. The liquid level is aligned with the horizontal scale of the hydrometer point to be calibrated and the reference density is determined at that point to get the correction for the scale. The horizontal scale setting, vertical alignment and reference liquid density are some of the key factors that need to be set and measured accurately to ensure the quality of results. The horizontal scale (point to be calibrated) is set with the assistance of a computer software and a magnifying camera. This setting also depends on how well the vertical alignment is set as the hydrometer is suspended from the balance. Distilled water (reference liquid) temperature is measured at three different levels and used to determine the liquid density at the time of measurement. In this work, we discuss the setup for the hydrometer system at NMISA with the main idea being to highlight the required improvements that still need to be implemented and to address all the uncertainty contributions associated with this system. We also report some results found for hydrometers calibrated at the minimum and maximum points of their respective scales using the current system. Three hydrometers with scale ranges of 0.600 – 0.700 g/ml, 0.700 – 0.800 g/ml and 0.800 – 0.900 g/ml were calibrated at a temperature of 20 ℃. The uncertainty of measurement was found to be ±0.001 g/ml.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Poster Session 2 - Board: 41 / **117**

Performance of various event generators in describing multijet final states at the LHC

Author: Stefan von Buddenbrock[1]

[1] *University of the Witwatersrand*

Corresponding Author: stefvonb@gmail.com

At the LHC, the most abundant processes which take place in proton-proton collisions are the generation of multijet events. These final states rely heavily on phenomenological models and perturbative corrections which are not fully understood, and yet for many physics searches at the LHC, multijet processes are an important background to deal with. It is therefore imperative that the modeling of multijet processes is better understood and improved. For this reason, a study has been done with several state-of-the-art Monte Carlo event generators, and their predictions are tested against both ATLAS and CMS data using the Rivet framework. The results display a mix of agreement and disagreement between the predictions and data, depending on which variables are studied. Several points for improvement on the modeling of multijet processes are stated and discussed.

**Apply to be
 considered for a student
   award (Yes / No)?:**

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

PhD

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Nuclear, Particle and Radiation Physics 2 / 118

Production of the Madala boson in association with top quarks

Author: Stefan von Buddenbrock[1]

[1] *University of the Witwatersrand*

Corresponding Author: stefvonb@gmail.com

The Madala hypothesis is the prediction of a new heavy scalar, the Madala boson, that has had previous success in explaining several anomalies in LHC Run 1 and 2 data. In the literature, the Madala boson has so far primarily been discussed in the context of its dominant production mode, gluon fusion. However, it can be shown that a study of its production in association with top quarks can provide us with crucial information about the model, as well as explain the enhancement of top associates Higgs production that has been observed in the data – most notably in leptonic channels. For this study, Monte Carlo events have been produced and passed through a detector simulation. These events are then run through every available analysis that studies top associated Higgs production by the ATLAS and CMS collaborations. With the Madala hypothesis prediction, an effective signal strength is calculated and compared with the observed values.

**Apply to be
 considered for a student
   award (Yes / No)?:**

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

PhD

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Photonics / 119

Multiplexing of a densely-packed set of spatial modes

Authors: Andrew Forbes[1]; Carmelo Rosales-Guzman[2]; NKOSIPHILE ANDILE BHEBHE[3]; Nyiku Mahonisi[4]

[1] *CSIR*

[2] *University of the Witwatersrand, Johannesburg*

[3] *UNIVERSITY OF THE WITWATERSRAND*

[4] *University of the Witwatersrand*

Corresponding Author: nkosiphile.bhebhe@students.wits.ac.za

Structured or custom optical fields have become useful tools for research and other technological applications. Of particular interest in many of these applications is the simultaneous generation of multiple beams (multiplexing). Technological advances have provided computer-controlled devices capable of generating a great variety of beam shapes that can be multiplexed and controlled individually. In principle, the number of multiplexed beams can be infinite, limited only by the resolution

of the generating device. Ultimately, this limitation translates in the decay of the beam quality, a disadvantage that has not yet been fully explored. Here, we investigate on the beam quality as function of the number of multiplexed modes to provide an upper bound to the maximum number of modes that can be multiplexed on a spatial light modulator with a resolution of 1920 × 1080. To find an upper bound we computed the correlation between the experimentally and theoretically generated modes as function of the number of multiplexed modes. These results can be of potential interest in the context of classical and quantum optical communication and optical trapping.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. Andrew Forbes

andrew.forbes@wits.ac.za

University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Applied Physics / 120

<u>Analysis and optimization of the pore structure development in activated carbon nanostructures</u>

Authors: Damilola Momodu[1]; Ncholu Manyala[2]; Tjatji Tjebane[3]

Co-author: Gabriel Nothnagel [4]

[1] *UNIVERSITY OF PRETORIA*

[2] *University of Pretoria*

[3] *Necsa/UP*

[4] *Necsa R&D*

Corresponding Author: tjatji.tjebane@necsa.co.za

The formation mechanism of the porous framework in nanostructured carbons is important in a wide variety of applications such as in supercapacitors, gas storage, adsorbents and catalyst supports etc. especially in the production of activated carbons which are now one of the most common, cheap and efficient materials adopted by researchers for these applications. 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, there is an important distinction between porosity that is connected to the exterior of the material surface, and porosity that is effectively inaccessible to ion/fluid transport from the interior. These can be clearly distinguished using small-angle neutron scattering contrast matching (SANS-CM) technique by suppressing the accessible pores whilst filling them up with a material with the same scattering density, such as toluene.
In this study, activated carbon (AC) was produced from renewable biomass waste using a chemical vapour deposition (CVD) technique via a pre-hydrothermal conversion step with optimization of key growth parameters. The textural, structural and morphological features were investigated by the Brunauer-Emmett-Teller (BET) technique, X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), and Scanning/Transmission electron microscopy (SEM/TEM) characterization. Finally the quantification of the accessible pores to optimize the surface area of the materials will be evaluated using SANS-CM.

The results analysed from this work would aid in the production of efficient and stable porous materials, from renewable waste sources, suitable for electrochemical and gas sensing applications.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. Ncholu Manyala
Ncholu.Manyala@up.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Nuclear, Particle and Radiation Physics 2 / 121

Composite scintillators - new type of radiation hard scintillator

Author: Joyful Mdhluli[1]

Co-authors: Andrey Boyarintsev [2]; Bruce Mellado [1]; ELIAS SIDERAS-HADDAD [1]; Harshna Jivan [1]; Ilya Vasiliev [3]; Rudolph Erasmus [1]; Skhathisomusa Mthembu [1]; Tatiana Nepokupnaya [2]; Vladimir Baranov [3]; Yuri Davydov [4]; Yuri Onufriyev [2]

[1] *University of the Witwatersrand*

[2] *Institute for Scintillation Materials of NAS of Ukraine*

[3] *Joint Institute for Nuclear Research*

[4] *Joint Institue for Nuclear Research*

Corresponding Author: joyemmie@gmail.com

Composite scintillators are new promising detectors for use in severe radiation environments. They consist of crystal granules embedded into an optical transparent medium. This ensures a high radiation hardness within the scintillator with comparison to normal plastic scintillators. However, composite scintillators are low opacity materials as a result of the light scattered by the small crystal granules.
We report on optical and structural properties of these composite scintillators after irradiation using a neutron beam of above 1*10ˆ(14) n/cmˆ(2) generated by the IBR-2 reactor at the Frank Laboratory of Neutron Physics in Dubna, Russia. The irradiation effects were characterized using Raman spectroscopy, Light yield and Light Transmission measurements. We further report on the advantages and disadvantages of these composite scintillators; and problems that need to be addressed. Preliminary results indicate a change in the light yield and light transmission after a certain neutron flux whilst no structural changes where observed from the Raman spectroscopy results.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Elias Sideras-Haddad, Elias.Sideras-Haddad@wits.ac.za, University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 58 / **122**

A spatial ptychographic phase retrieval algorithm for microscopic implementation in the NIR

Author: Anneke Erasmus[1]

[1] *Stellenbosch University*

The use of spatial ptychography, a lensless imaging technique, in microscopy is well established. A ptychographical iterative engine (PIE) is a phase retrieval algorithm used to reconstruct the amplitude and phase of the sample from its far-field diffraction patterns. This holds some advantages over conventional imaging. In this work, the PIE algorithm described uses, as input, the diffraction patterns recorded by illuminating a sample at various spatial positions with a 975 nm diode laser. The iterative algorithm reconstructs the image by allowing the phase to converge in the overlap regions between neighbouring illumination positions. This method implies that the resolution of this technique is not limited by optical elements in the setup such as lenses, but rather by the highest spatial frequency that can be recorded. An extension to the PIE is the ePIE (extended ptychographical iterative engine). In ePIE the probe beam used to illuminate the sample is also reconstructed, allowing for a faster reconstruction of the image and no a priori knowledge of the probe beam. Shown and discussed here are preliminary simulations that demonstrate this technique, as well as the setup of a ptychographic microscope.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof EG Rohwer
egr@sun.ac.za
Stellenbosch University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 19 / **123**

Electronic properties of B and Al doped <i>graphane</i>: A hybrid density functional study

Author: Edwin Mapasha[1]

Co-authors: Emmanuel Igumbor [1]; NOELIARINALA FELANA ANDRIAMBELAZA [1]; Nithaya Chetty [1]

[1] *University of Pretoria*

Corresponding Author: edwin.mapasha@up.ac.za

Recently, the two-dimensional (2D) material systems such as graphene, <i>graphane</i>, hexagonal boron nitride and various transition metal dichalconides monolayers have attracted great research interests owing to their peculiar properties. <i>Graphane</i>, a fully hydrogenated graphene, is a wide band gap semiconductor with a large exciton binding energy according to density functional theory (DFT) prediction. Modulating the electronic structure of a semiconductor material is essential for device operations. Doping is recently considered to be a powerful tool to fine tune the band gap of various semiconductor materials. Using the hybrid density functional theory (DFT) approach, we study the electronic properties of a <i>graphane</i> monolayer substitutionally doped with B (B_{CH}) and Al (Al_{CH}) atoms. The density of states (DOS) plot reveals that the band gap of <i>graphane</i> is slightly tuned down due to the B_{CH} doping. Different scenario is observed on the Al_{CH} DOS, where the metallic character has been noted due to the Al dependant spin states crossing the Fermi level. We further examine the response of the Al dependant spin states on the multiple charge states. An addition of the electrons retains the metallic character of Al_{CH}, while the positive charges re-open the band gap, although in a small amount of magnitudes. Our findings suggest the possibility of fine tuning the band gap of <i>graphane</i> through the defect and charge doping.

**Apply to be
 considered for a student
   award (Yes / No)?:**

no

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

no

Space Science / 124

Contribution of E x B drift to the low latitude TEC modelling during geomagnetic storms

Author: Jean Claude UWAMAHORO[1]

Co-author: John Bosco Habarulema [1]

[1] *South African National Space Agency (SANSA), Space Science*

Corresponding Author: juwamahoro@sansa.org.za

Due to the complicated nature of equatorial electrodynamics during geomagnetic storms, it was found that modelling ionospheric total electron content (TEC) is more difficult in the low latitude than in the mid-latitude. Towards the improvement of TEC modelling in the low latitude, E × B is introduced for the first time in TEC modelling as a new input, in addition to the standard inputs which represent solar and geomagnetic activities, diurnal and seasonal variations. For this purpose, Non linear Regression analysis (NLRA) model is developed using TEC data (1998 - 2016) derived from the Global Positioning Systems (GPS) measurements over Seychelles (SEY1, 4.67° S , 55.48° E). On the basis of statistics, the contribution of E x B drift to TEC modelling for the low latitude region is highlighted and results are compared with the International Reference Ionosphere (IRI) predictions.

**Apply to be
 considered for a student
   award (Yes / No)?:**

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

PhD

**Main supervisor (name and email)
and his / her institution**:

Dr John Bosco Habarulema
Email: jhabarulema@sansa.org.za

1. South African National Space Agency (SANSA), Space Science, 7200, Hermanus, South Africa.
2. Department of Physics and Electronics, Rhodes University, 6140, Grahamstown, South Africa.

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 20 / **125**

<i>Ab-Initio</i> study of Oxygen Adsorption on Li/Na-MO₂ (110) Surface, (M = Mn,Ti and V)

Author: khomotso Maenetja[1]

[1] *University Of Limpopo*

Corresponding Author: khomotso.maenetja@gmail.com

Metal air batteries have been studies extensively but operation of Na-air batteries has just gained attention recently. Catalytic effect on the performance of sodium air battery has not been an area of interest yet. However, it has been reported that the most stable product in Na-air battery is NaO₂ whereas in Li-air battery it has been reported that the major and stable product is Li₂O₂. In this paper, we present density functional theory study on how metal oxide (MnO₂, TiO₂ and VO₂) catalyst affects the formation of Li₂O₂ and NaO₂ and other products that may be formed. We further investigate the discharge products of these two metal air batteries compared to the known systems of the product in terms of their formation energy and their morphology. Looking into the O-O bond length which plays an important role in Oxygen Reduction Reaction (ORR) during discharge of the battery. Interestingly it has been found that what was reported in literature, that the most stable products in Na-air batteries being NaO₂ is indeed what has been observed in our study. Furthermore, the type of structure that has been found was the pyrite form whereas the most stable product in Li-air battery, Li₂O₂ has the hexagonal type. Amongst the three metal oxides it can be concluded that MnO₂, is the most favourable catalyst because it encourages the formation of the reported stable products in both metal air batteries.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof P. E. Ngoepe, phuti.ngoepe@ul.ac.za, University of Limpopo

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Space Science / **126**

Ionospheric Electrodynamics within the African sector

Author: Makhosonke Dubazane[1]

Co-author: John Bosco Habarulema [2]

[1] *SANSA Space Science*

[2] *South African National Space Agency*

Corresponding Author: mdubazane@sansa.org.za

E x B drift influences plasma distribution and dynamics; hence it has a significant impact on space weather. We are presenting the model of E x B drift developed from magnetic field measurements of a pair of magnetometers at dip equator (geomagnetic latitude: 0.17°N, geographic longitude: 38.77°E) and off- magnetic equator (geomagnetic latitude: 6.0°N, geographic longitude: 39.46°E) within the African sector. The model has been transferred to different equatorial longitude sector. Statistically, the correlation coefficient over 5.77°W longitude sector is 0.663 compared to 0.794 for the 38.77°E longitude sector. Quiet times (Kp≤3) results generated by the model will also be discussed and compared with ionosonde derived E x B drift.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

John Bosco Habarulema,jhabarulema@sansa.org.za, South African National Space Agency

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Applied Physics / **127**

The NMISA Watt balance

Author: Aletta Karsten[1]

Co-authors: Henk Potgieter [1]; Thapelo Mametja [1]

[1] *NMISA*

The international definition of the kilogram in the International System of Units (SI) has not been changed since 1889. The kilogram (unit of mass) is defined as the mass of a Platinum-Iridium (Pt-Ir) alloy cylinder that is kept at the International Bureau of Weights and Measures (BIPM) in Paris, France since 1889. This is about to change in 2018. The new definition will be based on a constant of nature.
The National Metrology Institute of South Africa (NMISA) is responsible for maintaining the SI units and to maintain and develop primary scientific standards of physical quantities for South Africa and compare those standards with other national standards to ensure global measurement equivalence. NMISA has embarked on a project to develop a Watt balance in preparation of the re-definition of mass.
As a first step in the process, NMISA built a Model Watt balance mainly from Lego blocks, a replica of the NIST Lego Watt balance and designed a Watt balance that was printed on a 3D printer. This paper will discuss the calibration procedure of a typical Watt balance and compare the results from

the Lego Watt balance to that of the 3D printed Watt balance and also discuss the major sources of errors in the system.

Summary:

The NMISA Watt balance will be discussed. The calibration results from a Lego system and a 3D printed Watt balance will be compared..

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 54 / **128**

System Control Applications of Low-Power Radio Frequency Devices

Author: Roger van Rensburg[1]

[1] *Wits*

Corresponding Author: roger.vanrensburg@wits.ac.za

This paper conceptualizes a low-power wireless network topology design for application employment to reduce theft of portable computer devices used in educational institutions today. The aim of this study is to design and develop a network topology that can eradicate accessibility of the device's human interface. An embedded system supplied by an energy harvesting source, installed on the portable computer device, will represent one of multiple slave nodes that acknowledge regular updates or heartbeats from a standalone master station. A portable computer device which is operated in an undesignated area or in a field perimeter where master to slave communication is restricted, indicating a possible theft scenario, will initiate a shutdown of its operating system and render the device unusable. Consequently, an algorithm in the device firmware may ensure the necessary steps are executed to track the device, irrespective whether the device is enabled. Design outcomes thus far indicate that a robust wireless network topology development, using low-power embedded hardware, is feasible. By incorporating one of the latest system-on-chip Bluetooth low-energy, ANT+, ZigBee or Thread wireless technologies, an anti-theft system can be implemented that has the potential to reduce major portable computer device theft in institutions of digitized learning. Many other diverse applications of low-power RF devices exists whereby the methods utilized in this study may aid in the continuous monitoring of critical instrumentation systems found in different niche fields.

Summary:

Field: Telecommunications and software engineering
Designing, simulating and development of a low-power wireless sensor network to protect computer handheld devices against theft in areas of digitized learning.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Prof Bruce Mellado
Bruce.Mellado@wits.ac.za
School of Physics

(Supervisor from School of Electrical pending)

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Photonics / **129**

Interference of distinguishable photon states

Author: Bienvenu Ndagano[1]

Co-authors: Andrew Forbes [2]; Jeonwan Jin [3]; Katanya Kuntz [3]; Sascha Agne [3]; Thomas Jennewein [3]

[1] *University of the Witwatersrand*

[2] *CSIR*

[3] *University of Waterloo*

Corresponding Author: nibienvenu@gmail.com

Intensity fringes are characteristic features of optical interference between spatially coherent fields. At the quantum level, interference expresses the distinguishability of a given observable. A classic illustration is Young's double slit experiment; the two slits are indistinguishable, causing the two paths taken by a single photon to interfere on a screen. However, the ability to measure interference is determined by the uncertainty of the detector. In the case of Young's double slit, Heisenberg position-momentum uncertainty determines the bounds of interference visibility, and thus the photon distinguishability. Here, we exploit a variant of Heisenberg uncertainty principle, a time-energy uncertainty, to demonstrate a quantum in energy and time, using distinguishable photons. The identity of photons as quanta of energy is generally encapsulated in the photon energy . However, a coherent superposition of distinguishable frequency states leads to interference in time which, manifests itself as a frequency beat that can only be observed, so long as it occurs within the detector's time uncertainty. We show that by marking the frequencies with polarisation, we can erase or unravel the frequency information, controlling the visibility of the frequency beating.

**Apply to be
 considered for a student
   award (Yes / No)?**:

YES

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Andrew Forbes
andrew.forbes@wits.ac.za
University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Theoretical and Computational Physics 1 / **130**

A gauge invariant truncation of JIMWLK

Author: Robert Moerman[1]

Co-author: Heribert Weigert [1]

[1] *University of Cape Town*

The Colour Glass Condensate captures QCD in its applications to high energy collider experiments in the spirit of an effective field theory using Wilson-lines and their correlators as the active degrees of freedom. The energy-dependence of these correlators is given by the JIMWLK equation which, when applied to a given correlator, generates an infinite tower of coupled equations referred to as a Balitsky hierarchy.

In this talk, I present a general method for truncating any Balitsky hierarchy in terms of energy-dependent colour structure functions analogous to the parametrization of hadronic cross-sections in terms of hadronic structure functions within the parton model. I also discuss the properties of these colour structure functions which are universal; they are constrained by group theoretic considerations independently of the Balitsky hierarchy being considered.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Heribert Weigert heribert.weigert@uct.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Theoretical and Computational Physics 1 / 131

A semiclassical recipe for wobbly limp noodles in partonic soup

Author: Robert Moerman[1]

Co-author: William Horowitz [1]

[1] *University of Cape Town*

Corresponding Author: robert.william.moerman@gmail.com

In this talk, I present the main results of our recent paper where we compute the average squared distance travelled by an initially stationary light-flavour off-mass-shell coloured parton in a strongly-coupled thermal plasma using the gauge/string duality. The calculation involves taking an ensemble average of thermal fluctuations induced by Hawking radiation emanating from the black hole horizon in AdS_d -Schwarzschild on top of the leading order worldsheet of our limp noodle string. We argue that our results give us access to the time-dependent transverse momentum squared per unit pathlength picked up by a high momentum quark in a strongly-coupled thermal plasma and present the first time-dependent calculation of the transport coefficient, which is critically important for phenomenology in heavy ion collisions.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

William Horowitz wa.horowitz@uct.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Physics of Condensed Matter and Materials 1 / 132

Implementation of Quantum Hall Effect Based Precision Resistance Measurement System

Author: Mporome Maboko[1]

[1] *Student*

The National Metrology Institute of South African (NMISA) has a mandate to implement a primary resistance standard and to upgrade the DC resistance Laboratory. The Quantum Hall Effect (QHE) is the foundation for the implementation of the primary resistance standard. The QHE is a phenomenon that occurs in a two-dimensional electron gas (2DEG) when subject to a strong magnetic field perpendicular to the direction of current flow when the system is cooled down to low temperatures. MOSFETs or GaAs/AlGaAs devices are used for the QHE. The GaAs/AlGaAs heterostructure is the preferred material due to its high mobility □ and carrier concentration □.

Electron density in the range of (3 to 5.5) x 10ˆ15 mˆ-2 is suitable in order to obtain wide and well quantised □=2 plateau at 1.5 K and magnetic field in the range of 6 T to 11 T (Delahaye & Jeckelmann, 2003). The passing of current in the 2DEG in the presence of a strong magnetic field results in a transverse voltage called the Hall voltage V(H), the ratio of the Hall voltage to current has the units of resistance (Ω). The Hall voltage manifests itself as quantised plateaus where each plateau is a multiple of the Klaus von Klitzing constant given by

□(□)=h/□□ˆ2 = 25812.807 Ω

which is given by fundamental constants. In this talk, I will present an introduction to the techniques used to realise a standard of electrical resistance based on the QHE and show the latest results from our group in the Department of Physics at UCT.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Mark Blumenthal
mark.blumenthal@uct.ac.za
UCT

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Applied Physics / 133

Natural Air Change Rate Analysis of a Passive Solar House in Alice, South Africa

Author: Ochuko Kelvin Overen[1]

Co-authors: Edson Leroy Meyer [2]; Golden Makaka [3]; Sampson Mamphweli [4]; Sosten Ziuku [4]

[1] *Fort Hare Institute of Technology, University of Fort Hare*

[2] *Fort Hare Institute of Technology*

[3] *Physics Department*

[4] *University of Fort Hare*

Corresponding Author: ooveren@ufh.ac.za

Air tightness is an essential feature for minimizing heat exchange between the inner space and ambient environment of a building. On the other hand, shortage of air exchange can also result in indoor discomfort, which is associated with inadequate ventilation, poor air quality and building related illness. The aim of this study is to analyze the natural air exchange rate and indoor air quality of a passive solar house. The ASTM E741-11 standard method for determining air change rate in a single zone by means of Tracer Gas Dilution was adopted. A Non-Dispersive Infrared CO2 gas sensor was used to measure the indoor CO2 concentration. To investigate the effects of each of the ventilation components of the house, the tests were carried out in four stages; (i) all doors and windows open, (ii) all doors closed and windows open, (iii) all doors open and windows closed, and (iv) all doors and windows closed. Indoor and outdoor meteorological parameters were also monitored. The average indoor temperatures during the test period were 18.5℃, 19.0℃, and 19.5℃ for the north bedroom, south bedroom and living room/kitchen respectively, while the outdoor ambient temperature was 16.7℃. An average wind speed of 1.4 m/s at 158 (68 South of East) was observed. The south bedroom has the longest decay period of 62 min with a CO2 exchange rate of 0.52 per hour. Whilst the living room/kitchen with a CO2 exchange rate of 0.61 per hour had the shortest decay period of 13 min. The heat flow rate through the windows and building envelope were 140 J/s and 24 J/s, respectively. The overnight indoor CO2 concentration was found to be 0.248%, which is less than the indoor air quality maximum safe limit of 0.500%, in South Africa. It was observed that the heat flow rate depends on the ambient wind speed and direction. With proper operation of the widows by the occupants, passive cooling can be achieved in summer and the wind chill factor can be drastically reduced or even avoided in winter. This will promote indoor thermal comfort and enhance thermal energy efficiency.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Edson L. Meyer/ emeyer@ufh.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Theoretical and Computational Physics 1 / 134

GLOBAL SOLAR RADIATION ESTIMATION USING TEMPERATURE DATA FOR NWANEDI ARC STATION OF VHEMBE DISTRICT, SOUTH AFRICA.

Author: Nnditshedzeni Eric Maluta[1]

Co-author: Sophie Mulaudzi [1]

[1] *University of Venda*

Corresponding Author: eric.maluta@univen.ac.za

In developing countries like South Africa the global solar radiation and its components is not available for all locations due to the lack of weather station and the cost of establishing them. Thus there is a dire need of using different theoretical models for the estimation of global solar radiation using different climatological parameters at a given locations. In this study, two temperature based model developed by Clemence and Hargreaves & Samani were employed to estimate global solar radiation from the temperature data measured at Nwanedi ARC station. The models studied were calibrated using five years temperature data. Estimated values were compared with measured values in terms of statistical evaluation indicators like the coefficient of determination (R2), mean percentage error (MPE), mean bias error (MBE) and root mean square error (RMSE). The statistical analysis showed that the models assessed were well suited to accurately estimate the solar potential at Nwanedi area.
The two equations used are:
1. H= (1.233*H₀*ΔT+10.593*T_{max} -0.713*T_{max} ΔT+16.548)*0.0418
2. H=H₀K_r(√ΔT)
were H₀ is the extraterrestrial radiation, T_{max} is the daily maximum temperature, ΔT is the difference between the daily maximum and minimum temperature and h is the global solar radiation
Keywords: Solar radiation, temperature, extraterrestrial radiation

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Poster Session 1 - Board: 36 / **135**

Probing quantum gravity through strong gravitational lensing

Author: Stuart Marongwe[1]

Co-author: Mhlambululi Mafu [1]

[1] *Botswana International University of Science and Technology*

Corresponding Author: stuartmarongwe@gmail.com

We report the use of Einstein rings to reveal the quantized and dynamical states of space-time in a region of impressed gravitational field as predicted by the Nexus Paradigm of quantum gravity. This in turn reveals the orbital speeds of objects found therein and the radius of curvature of the quantized space-time. Similarities between the Nexus graviton and the singular isothermal sphere (SIS) in the Cold Dark Matter (CDM) paradigm are highlighted. However unlike the singular isothermal sphere, the Nexus graviton does not contain singularities or divergent integrals. This solves the core cusp problem. In this work, data from a sample of fifteen Einstein rings published on the Cfa-Arizona Space Telescope Lens Survey (CASTLES) website is used to probe the quantized properties of space-time.

**Apply to be
 considered for a student
   award (Yes / No)?:**

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Dr Mhlambululi Mafu
Lecturer, Department of Physics and Astronomy
Botswana International University of Science and Technology (www.biust.ac.bw)
Plot 10017, Palapye, Botswana
Private Bag 16, Palapye, Botswana
Tel: +267 4931567
Cell: +267 75718553
Email: mafum@biust.ac.bw
Personal Webpage: www.mhlamafu.com

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Theoretical and Computational Physics 1 / 136

Solution of double-eigenvalue problem for a fermionic particle or gauged Q-ball in superfluid vacuum

Authors: Arislan Makhmudov[1]; Konstantin Zloshchastiev[2]; Vladimir Dzhunushaliev[3]

[1] *Peoples' Friendship University of Russia, Moscow*

[2] *Durban University of Technology*

[3] *Al-Farabi Kazakh National University*

Corresponding Author: arslan.biz@gmail.com

A model describing a fermionic particle or Q-ball in a superfluid vacuum is studied numerically. We show that it is a nonlinear double-eigenvalue problem, which thus requires a special treatment. The essential equations to solve are four nonlinear differential equations involving the spinor, electrostatic, and the logarithmically nonlinear scalar field which effectively describes background superfluid in a low-energy regime. The solution is derived in a recursive way, a detailed example demonstrating this process is presented. Among other values, self-energy and total charge of the object are numerically derived. The main conclusion is that our model is free of field singularities, its self-energy is finite and its electric field obeys the Coulomb asymptotics.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. K. A. Bronnikov, Institute of Gravitation and Cosmology, Peoples' Friendship University of Russia, 6 Miklukho-Maklaya St., Moscow 117198, Russia
kb20@yandex.ru

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Photonics / **137**

Image Inversion via Quantum Ghost Imaging

Author: Nicholas Bornman[1]

Co-authors: Andrew Forbes [1]; Jonathan Leach [2]; Megan Agnew [2]

[1] *University of the Witwatersrand*

[2] *Heriot-Watt University*

Corresponding Author: 442571@students.wits.ac.za

Quantum ghost imaging is one of the many unanticipated and yet wonderful peculiarities arising from quantum mechanics. The basic proposal behind it is using a pair of entangled photons, one of which strikes an arbitrary object, and being able to reconstruct an image of the object by observing the other photon. In this study we use an experimental setup involving a couple of tiers of crystals which create two pairs of entangled photons via spontaneous parametric down conversion (SPDC). A photon from each pair is combined using a beam-splitter and the entanglement is teleported between the remaining two photons by ensuring 4-way coincidences using detectors. Simultaneously, an object is created in one of the remaining arms by masking a spatial light modulator (SLM), and the measured image is observed using another SLM in the final arm. By carefully choosing the way measurements are performed, we theoretically predict the contrast inversion of the ghost image, i.e. the observed image is inverted with respect to the object mask, a most interesting result. However, strangely, it appears as though this inversion is predicated on the use of an anti-symmetric state for the beam-splitter photons; for a symmetric state, the image may or may not be inverted, depending on the object's dimensions and the way measurements are performed. Despite this, our work highlights, in a completely new context, the fundamental role measurements play in quantum theory, since in both the symmetric and anti-symmetric cases, the observed image depends greatly on the way the SLM screens are measured. We hope to confirm these theoretical predictions with experimental results in the near future.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Ph.D.

**Main supervisor (name and email)
and his / her institution**:

Prof. Andrew Forbes

Andrew.Forbes@wits.ac.za

School of Physics, University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 21 / **138**

Optimisation of inorganic-organic photoactive hybrid film for photovoltaic application.

Author: Siphisihle Siphamandla Magubane[1]

Co-author: Theophillus Muller [1]

[1] *UWC*

Photoactive hybrid films based on inorganic-organic nanocomposites have attracted a lot of attention for fabrication of low cost and environmental friendly off grid photovoltaic devices.^{1,2} In particular, silicon nanowires (SiNWs), electron accepting materials and poly (3-hexylthiophene) (P3HT), electron donor conjugated polymer are promising candidates due to high optical absorption and excellent charge carrier mobility associated with them respectively.^{3,4} An objective of the study was to establish optimised spin coating conditions for P3HT film deposition with high film uniformity and electrical conductivity in order to incorporate SiNWs for enhancement of optical and electrical properties of the film. Spinning speed, duration and solution concentration were studied as experimental parameters. Uniform films with satisfactory electrical conductivities were obtained.

Keywords: Spin coating, inorganic-organic nanocomposites, photoactive hybrid film

References

1. M. Braik, C. Dridi, A. Rybuk, J. Davenas and D. Cornu. Physica Status Solid Applications and Materials, (2013) 1-7.
2. J. Davenas, S.B. Dkhil, D. Cornu and A. Raybak. Energy Procedia, 31 (2012) 136-143.
3. W. Cao, A. Uddin and M. Wright. Solar, 2012, the 50th AuSES Annual Conference.
4. K. Liu, S. Qu, X. Zhang, F. Tan and Z. Wang. Nanoscale Research letter, 8 (2013) 1-6.

Summary:

In summary, the polymer was dissolved in a binary solvent of dichlorobenzene and chloroform. Subsequently, SiNWs synthesised via metal assisted chemically etching were added into solution. The mixture was then stirred on digital hot plate stirrer at room temperature for at least 12 hours. The resulting solution which consisted of both SiNWs and P3HT was then deposited on a glass substrate by means of spin coating. Finally, the thickness measurements, electrical and optical properties investigations were performed using Dektak 6M stylus profiler, Hall effect measurement system(HMS-3000) and Optical mini spectrometer respectively.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Theophillus Muller, tmuller@uwc.ac.za, University of the Western Cape.

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Nuclear, Particle and Radiation Physics 2 / 139

Quark gluon tagging at the LHC

Author: Deepak Kar[1]

[1] *University of Witwatersrand*

Corresponding Author: deepak.kar@cern.ch

By measuring the substructure of a jet, one can assign it a quark or gluon tag. In this talk, we confront the challenges faced when going beyond this leading-order understanding, using both parton shower generators and first-principles calculations to assess the impact of higher-order perturbative and nonperturbative physics. Working in the idealised context of electron-positron collisions, where one can define a proxy for quark and gluon jets based on the Lorentz structure of the production vertex, we find a fascinating interplay between perturbative shower effects and nonperturbative hadronization effects. Turning to proton-proton collisions, we highlight a core set of measurements that would constrain current uncertainties in quark/gluon tagging and improve the overall modeling of jets at the Large Hadron Collider.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

The contributor is an academic staff member.

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Applied Physics / 140

Neutron and X-Ray Radiography/Tomography Reveal Secrets and Mysteries of our Past

Author: Frikkie De Beer[1]

[1] *Necsa*

Corresponding Author: frikkie.debeer@necsa.co.za

The use of radiation in modern life is merely known for the X-ray diagnostics in the case of X-rays and nuclear power reactors in the case for neutrons. Few people have the unfortunate experience of using nuclear medicine (radiation) in the treatment of illness. However, the application of radiation as a research tool is merely unknown also in revealing those hidden secrets of the past. Heritage is our legacy from the past, what we live with today and what we should pass on to future generations. Our cultural and natural heritages are both irreplaceable sources of life and inspiration - places such as the wilds of East Africa's Serengeti, Cradle of Humankind in South Africa, the Pyramids of Egypt, the Great Barrier Reef in Australia and the Baroque cathedrals of Latin America. World Heritage sites belong to all the peoples of the world, irrespective of the territory on which they are located and should be treated in the most responsible manner.
It is a universal need to reveal those secrets and in most cases hidden features of findings such as artifacts or fossils. Non-invasive techniques to preserve the findings during its analysis is one of the best ways to reveal secrets in the most a responsible manner also to be studied by future generations with possible new developed analytic techniques.
Today, neutron and X-ray based analytical techniques play an important role in both applied research and practical applications. Both neutron and X-ray imaging techniques do not offer directly analysis of elemental composition of studied entities. However, its non-invasive nature to study also objects from cultural heritage is of high value, where these probes reveal valuable hidden information non-destructively.

Summary:

The aim of this presentation is to highlight the non-destructive analysis of cultural artefacts using the capabilities of neutrons and X-ray's as radiation based penetrating probes. Several case studies will be discussed where neutron and X-ray radiography / tomography investigations of cultural artefacts are being practiced in South Africa and at a few international research institutions.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Nuclear, Particle and Radiation Physics 2 / 141

The production of two leptons and missing energy from H->Sh production at the LHC

Author: Abdualazem Fadol[1]

Co-author: Bruce Mellado [1]

[1] *University of the Witwatersrand*

Data reported by the ATLAS and CMS experiments at the Large Hadron Collider (LHC) involving final states with two charged leptons (electrons or muons) and missing energy is studied. These data are analysed in terms of the production of a heavy boson, H, decaying into the Higgs boson, h, and an additional scalar mediator, S. The mass of H is assumed to be around 270 GeV and the mass of S lies in the range m_h<m_S<m_t, where m_h and m_t correspond to the masses of the Higgs boson and the top quark. Two models are used to describe the decay of S into charged leptons and missing energy.

**Apply to be
 considered for a student
   award (Yes / No)?:**

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

MSc

**Main supervisor (name and email)
and his / her institution:**

Prof. Bruce Mellado Garcia (Bruce.Mellado.Garcia@cern.ch)/ University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Theoretical and Computational Physics 1 / 142

Correlation energy of a finite single chain lattice using a Harthree+Exchange approximation, a Jastrow factor and a local density approximation

Author: Kossi Amouzouvi[1]

Co-author: Daniel Joubert [2]

[1] *University of the Witwatersrand*

[2] *School of Physics, University of the Witwatersrand*

Corresponding Author: 1133362@students.wits.ac.za

We perform a Hartree+Exchange approximation on a finite one dimensional lattice of fractional particle number using the Hubbard Hamiltonian. The resulting approximate Kohn-Sham ground state wavefunction is then acted on by a Jastrow factor operator to retrieve the exact correlation energy and the interacting density that we use for a local density approximation (LDA) of the correlation energy in two different ways. The first approach makes use of the ensemble (fractional) density to get the energies and the second one interpolates the energies between integer particle numbers. An insight into the different results shows that the second approach is more promising and the underlying homogeneous energy density is suitable for applications of LDA.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. Daniel Joubert
daniel.joubert2@wits.ac.za

National Institute for Theoretical Physics, School of Physics and Mandelstam Institute for Theoretical Physics, University of the Witwatersrand, Johannesburg, Wits 2050, South Africa.

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Space Science / **143**

Polarity switches, coexistence and the existence of supersolitons pertaining to electron-acoustic nonlinear structures

Author: Shimul Maharaj[1]

Co-author: Ramesh Bharuthram [2]

[1] *South African National Space Agency (SANSA) Space Science*

[2] *University of the Western Cape*

Corresponding Author: smaharaj@sansa.org.za

Large amplitude electron-acoustic solitons are revisited in order to gain insights into why the phenomena of polarity switches, coexistence as well as the existence of supersolitons have been widely reported for ion-acoustic and dust-acoustic nonlinear structures but much less frequently for high frequency (electron-acoustic) nonlinear fluctuations associated with electron dynamics. The effect of streaming (warm) electrons is considered to determine to what extent is a beam responsible for supporting a switch in polarity from negative to positive polarity electron-acoustic solitons. Our results demonstrate that coexistence of negative and positive polarity electron-acoustic solitons and the existence of supersolitons of the electron-acoustic type are not easily amenable to models in which the positive species constituents are only protons. Consequently, we do not restrict our study to considering multi-temperature electron models containing only protons but models which are composed of protons and (much lighter therefore more mobile) positrons are also investigated.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Physics Education / 144

The 'Misconception' of 'Common Sense': An Introspective Approach

Author: Marthinus Johannes Schwartz[1]

[1] *University of Zululand*

Corresponding Author: mj.scienceguy@gmail.com

Students' introduction to physics is not devoid of prior schools of thought, where the students are the blank slates upon which the knowledge of physics is inscribed. Students possess their own prerequisite theories, concepts and intuition that have been extensively formed through their personal experience. This prior system of thought that has been fashioned from personal experience will commonly construct conclusions that are divergent from the academically accepted viewpoint of physics. These divergent viewpoints share an assortment of terms in physics education being labelled as preconceptions, alternative conceptions, misconceptions, common sense concepts and spontaneous knowledge. This prior established system of thought is resilient to change, where the student is not easily persuaded to abound their common sense belief simply because it has been branded as erroneous and exiled to the wilderness of 'misconceptions'. The common sense theory that is in contention to the established scientific theory can be further reinforced, if it was not adequately addressed, by the student's prior academic exposure, with the one feeding off the other. To address this dilemma requires an introspective approach, mixing the practical with the theoretical. How this is being done, and what other approaches physics education can utilize will be addressed.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 22 / **145**

 Quasipartice Band Structure and Optical Properties of α-MnO<sub>2</sul : A Beyond Density Functional Theory Investigation

Author: Mirriam Chepkoech[1]

Co-authors: Daniel Joubert [1]; George Amolo [2]

[1] *The National Institute for Theoretical Physics, School of Physics and Mandelstam Institute for Theoretical Physics, University of the Witwatersrand, Johannesburg, Wits 2050, South Africa.*

[2] *Department of Physics and Space Science, The Technical University of Kenya, Po Box 52428-00200 Nairobi, Kenya.; The National Institute for Theoretical Physics, School of Physics and Mandelstam Institute for Theoretical Physics, University of the Witwatersrand, Johannesburg, Wits 2050, South Africa.*

Corresponding Author: chepkoechmirriam@gmail.com

The quasi-particle band structure and the optical properties of spin polarized bulk α-MnO₂ have been investigated by means of many body perturbation theory within an <i>ab</i> <i>initio</i> framework. As a starting point the electronic band structure obtained from Density Functional Theory with Hubbard correction (DFT+U, U = 2.4 eV) approach show that bulk α-MnO₂ is a semiconductor with a band gap of 1.284 eV. Quasi-particle band structure within the G₀W₀ level of approximation yields a band gap of 2.38 eV. Moreover, for the optical properties calculations, two particle excitations have been included through solving the Bethe-Salpeter equations (BSE) for the electron-hole pair correlation function. The peaks in the optical spectra are discussed based on the transitions within the computed band structure. From our results, the structure exhibits a strong optical absorption in the visible region along all the crystallographic directions. The optical anisotropy in this material is analyzed by means of dielectric function as well as the optical absorption coefficients along different principal axes. For instance, in the visible region, the calculated values for the highest absorption coefficients are 3.69×10^{−5}cm^{−1} along [100 and 010] and 6.32×10^{−5}cm^{−1} along [001] components. This clearly indicates the optical anisotropic behaviour in α-MnO₂. The optical absorption spectrum predicts a strong bound exciton that lies below the calculated quasi-particle band gap with binding energy of 0.65 eV in the bulk α-MnO₂.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. Daniel Joubert

Daniel.Joubert2@wits.ac.za

The National Institute for Theoretical Physics, School of Physics and Mandelstam Institute for Theoretical Physics, University of the Witwatersrand, Johannesburg,
Wits 2050, South Africa.

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Nuclear, Particle and Radiation Physics 2 / 146

Multilepton signatures of BSM scalar bosons at the LHC

Author: Mukesh Kumar[1]

[1] *University of the Witwatersrand*

Corresponding Author: mukesh.kumar@cern.ch

We study the signature of beyond Standard Model (BSM) scalar bosons through multi-lepton final states. In here we consider H > Sh decay modes, with mass of BSM scalars 250 <= m_H <= 300 GeV and 140 <= m_S <= 160 GeV and the mass of SM Higgs boson m_h = 125 GeV. In particular S and h

allowed to decay in all possible modes, where we analyse only same/opposite - sign/flavour leptons for the study.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Poster Session 2 - Board: 59 / **147**

Experimental realisation of a magneto optical trap of Rb-85 – cold atoms

Author: Yaseera Ismail[1]

Co-authors: Francesco Petruccione [1]; Kristoffer Karlsson [2]; Micheal Morrissey [3]; Sanele Dlamini [4]; Sile Nic Chromaic [5]; Tridib Ray [5]

[1] *UKZN*

[2] *Light-Matter Interactions Unit, Okinawa Instiute of Science and Technology Graduate University*

[3] *Institute of Physics, Academy of Sciences of the Czech Republic, Prague*

[4] *University of KwaZulu-Natal*

[5] *Light-Matter Interactions Unit, Okinawa Institute of Science and Technology Graduate University*

Corresponding Author: yaseera.ismail064@gmail.com

Magneto-optical trapping (MOT) is a standard tool for the creation of cold atom. The development of cold atom experiments has led to the advancement of many fields, which includes high precision metrology [1], atomic and molecular physics [2, 3] as well as atom optics [4]. Magneto- optical trapping is implemented by using the combination of on-resonant laser cooling techniques, to provide a velocity dependent force and magnetic trapping, to provide a position dependent force. This allows for the confinement of atomic samples with a relatively large number of atoms (108 atoms for a standard setup) at an extremely low temperature (in the µK range) in a locally small volume of space [5].

Here we present, the experimental realisation of a cold atom trap in a MOT configuration, which was implemented at the University of KwaZulu-Natal, Quantum Research Group, South Africa. It involves laser cooling and trapping of Rb-85 atoms by means of a three beam retro-reflected MOT. The experimental system comprises of the following sub-systems: a vacuum system in which the cooling and trapping takes place in a 6 beam configuration, a laser system which provide the optical power for cooling, a magnetic field which creates a trapping force for the atom and an imaging system which can be used to determine the properties of the atomic cloud. An overview of these systems will be presented as well as the experimental results of creating a MOT for trapping Rb-85 atoms.

References
[1] T. Udem, R. Holtzwarth, and T. W. Hänsch, Nature 416 233 (2002).
[2] D. W. Sesko, T. G. Walker, and C. E. Wieman, J. Opt. Soc. Am B. 8 946 (1990).
[3] E. A. Donley, N. R. Claussen, S. T. Thompson and C. E. Wieman, Nature 417 529 (2002)
[4] I. G. Hughes, P. A. Barton, T. M. Roach, M.G.Boshier and E. A. Hinds, J. Phys. B. 30 647 (1997).
[5] E. L. Raab, M. Prentiss, A. Cable, S. Chu and D. E. Pritchard, Phys. Rev. Lett. 59 2631 (1987).

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Photonics / **148**

Phase and time-dependent second harmonic measurements of centrosymmetric materials

Author: Wilfrid Innocent Ndebeka[1]

Co-authors: Erich Rohwer [2]; Pieter Neethling [1]

[1] *Laser Research Institute, University of Stellenbosch*

[2] *University of Stellenbosch*

Corresponding Author: ndebeka@sun.ac.za

Optical second harmonic generation (SHG) is widely used as non-invasive technique to probe surfaces and interfaces of centrosymmetric materials, e.g. silicon/silicon dioxide (Si/SiO2) and the bulk crystal structure of non-centrosymmetric materials such as silicon carbide (SiC). The time-dependent SHG observed at the Si/SiO2 interface of a bulk Si is caused by multiphoton excitation of electrons from the Si valence band to the oxide conduction band, resulting to their slow diffusion into the oxide surface traps. An interfacial electric field gradually builds-up which enhances the generated SH by electric field induced second harmonic (EFISH) generation over several minutes. In this work, an experimental setup-up, for frequency-domain measurement of SH phase as well as the time dependent second harmonic measurements of p-doped Si, will be presented and the obtained results are shown and discussed.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Main supervisor (name and email)
and his / her institution:**

Erich Rohwer (egr@sun.ac.za)
Laser Research Institute, Physics Department.
Stellenbosch University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Poster Session 2 - Board: 42 / **149**

Study of Excited 0+ States via Electron Spectroscopy

Author: Bonginkosi Zikhali[1]

Co-authors: Abraham Avaa [2]; Pete Jones [3]; Robbie Lindsay [4]

[1] *University of wersten cape physics*

[2] *University of Witwatersrand*

[3] *iThemba LABS*

[4] *University of the Western Cape*

Corresponding Author: bzzikhali191@gmail.com

A state of the art electron spectrometer for the measurement of internal conversion electrons is undergoing development at iThemba LABS. The spectrometer will be used to study the nuclear configuration of multiple excited 0+ states such as in Cd nuclei. The study focuses on the high-energy internal conversion electrons and through pair production from these nuclei. At present, measurements of 226Ra and 207Bi decay spectra have been carried out to optimize the energy efficiencies and resolutions of the detectors for the implementation of excited 0+ state studies of high-energy electrons with magnetic solenoid spectrometers. 226Ra and 207Bi were used as the sources of radiation, where alpha particles and electrons were emitted, respectively.In this presentation, the results for the energy resolution together intrinsic and absolute energy efficiencies of detectors for future use in experiments will be presented.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PHD

**Main supervisor (name and email)
and his / her institution**:

Dr Pete Jones,
emaile: pete@tlabs.ac.za
iThemba LABS,

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

no

Space Science / 150

Black aurora studies in the ionosphere.

Author: Amore Nel[1]

Co-author: Mike Kosch [2]

[1] *SANSA*

[2] *SANSA Space Science*

Black auroras are small regions of reduced optical emissions, embedded in the much brighter diffuse background aurora. They are usually seen drifting eastward during the substorm recovery phase, post-magnetic midnight. Although several theories have been proposed to explain the decrease in precipitating electron flux in these localised regions, the underlying mechanism is as yet unknown. This phenomenon has been studied before using optical observations. Uniquely, we study the black aurora using the EISCAT incoherent scatter radar in Tromso, Norway, in conjunction with dual-wavelength optical observations at 427.8 and 844.6 nm. From these data, the characteristic electron energy inside and outside the black aurora can be estimated. First results are presented here.

Summary:

First results are shown of characteristic energies of both inside and outside the black aurora using optical and radar methods. Future work using satellite data are also discussed.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

M.J. Kosch

mkosch@sansa.org.za

SANSA Space Science

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 60 / **151**

High dimensional quantum key distribution with vector modes

Author: Isaac Nape[1]

Co-authors: Andrew Forbes [2]; Benjamin Perez-Garcia [3]; Bienvenu Ndagano [4]; Filippus Roux [5]; Raul Hernandez-Aranda [6]; Stirling Scholes [2]; Thomas Konrad [7]

[1] *Structured Light Lab, School of Physics, University of Witwatersrand*

[2] *University of Witwatersrand*

[3] *Photonics and Mathematical Optics Group, Tecnológico de Monterrey*

[4] *University of the Witwatersrand*

[5] *National Metrology Institute of South Africa*

[6] *Tecnol´ogico de Monterrey*

[7] *UKZN*

Corresponding Author: isaacnape@gmail.com

Secure key generation and distribution schemes are essential for establishing secure communication networks against any potential eavesdropping. Quantum key distribution (QKD) offers the advantage of having a provably security scheme that is guaranteed by quantum mechanics. Previous implementations relied on polarisation qubit (d=2 dimensional) photonic state manipulation which impose limits on the information capacity to one bit per photon where in general the capacity is log2(d) for a d-dimensional encoding alphabet. Increasing the dimensionality of the encoding alphabet by exploring alternative degrees of freedom has become topical. Recent demonstrations have shown the advantage of using the transverse spatial modes of photons owing to their description on an infinite dimensional state space. Here we exploit a class of spatial modes, called vector modes, with non-separable orbital angular momentum and polarisation coupled states in the BB84 prepare and measure QKD protocol. We generate these modes by manipulating the dynamic and geometric phase control of light. Furthermore, we present a lossless scheme that deterministically sorts the spatial modes and shows an increase in the information capacity in comparison to the current state-of-the-art probabilistic sifting methods that are mainly employed in high dimensional QKD schemes.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Andrew Forbes
andrew.forbes@wits.ac.za
University of Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 43 / **152**

Searching for the low-energy enhancement in 91-Zr

Author: Bonginkosi Zikhali[1]

Co-authors: Bonginkosi Kheswa [2]; Mathis Wiedeking [2]; Sifiso Senzo Ntshangase [3]

[1] *University of Zululand*

[2] *iThemba LABS*

[3] *University of Cape Town / iThemba LABS*

Corresponding Author: bzzikhali191@gmail.com

The nuclear level density (NLD) and γ-ray strength function (γSF) are quantities that give essential information about the behaviour of a nucleus at high excitation energy. NLD is defined as the number of levels per unit of excitation energy. γSF is defined as a measure of the average reduced γ decay probability of a nucleus. These concepts are useful at high excitation energies where the spacing between the levels is small and gives information on degrees of freedom and underlying nuclear dynamics. The evidence of the low-energy enhancement in the γSF for energies less than 4 MeV has been discovered in several nuclei. Recently, a strong enhancement of M1 transitions in 90Zr has been predicted for γ-ray energies below 2 MeV in shell model calculations. In this work we explored the existence of the low-energy enhancement in the neighbouring 91Zr isotope with the assumption that neigbouring isotopes have similar γSF and hence provided first experimental NLD and γSF for this nucleus. The experiment 90Zr(d,p)91Zr was conducted at the Oslo Cyclotron Laboratory (OCL). The SiRi (silicon telescope) array was used to detect charged ejectiles from the reaction. The CACTUS (NaI(Tl) detectors) array was utilized to detect γ rays that were in coincidence with charged particles. The nuclear level density and γSF were extracted with the Oslo method. The existence of the LEE was observed, which agrees with the shell model calculations in 90Zr. The NLD and γSF quantities were used to calculate (n,γ) cross sections with the Talys reaction codes. These were compared with experimental data from direct measurement to test the reliability of of the approach used in this work.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

no

Photonics / **153**

Delayed measure quantum eraser with orbital angular momentum

Author: Isaac Nape[1]

Co-authors: Andrew Forbes [2]; Bienvenu Ndagano [3]

[1] *Structured Light Lab, School of Physics, University of Witwatersrand*

[2] *University of Witwatersrand*

[3] *University of the Witwatersrand*

Corresponding Author: isaacnape@gmail.com

Wave-particle duality is one of the most intriguing features of quantum mechanics that has been traditionally investigated through modern variations of Young's double slit experiment. When the paths of the double slit are marked with orthogonal polarisations of light, the path information is revealed and no interference pattern is observed. However, the interference can be erased with a complimentary analysis of the polarisation. Here we generalise the concept of path, showing that it need not be physical but can be abstract and employ another degree of freedom (DoF). Alternatively, we replace the paths with the orbital angular momentum (OAM) DoF and use polarisation as the marker. Then, the interference fringes due to OAM interference are observed in the azimuthal direction with a frequency proportional to the amount of OAM carried by the photon. We show this by generating hybrid entanglement between polarisation and OAM. First, we generate OAM entanglement using spontaneous parametric down conversion where a high frequency photon is absorbed by a non-linear crystal and produces two correlated lower frequency photons. Then we employ geometric phase control to convert the OAM of a twin photon to polarisation. Finally, we show that just as in Young's double slit, it is possible to distinguish and erase the OAM of a twin photon through polarisation control of its twin. In addition we also perform the experiment in a delayed measure scheme where the polarisation measurement is performed after the interference is analysed.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Andrew Forbes
andrew.forbes@wits.ac.za
University of Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Applied Physics / 154

The Development of a Meteorological Index to characterise the variation of spectral change on the operational performance of various Photovoltaic Technologies

Author: Ross Schultz[1]

Co-authors: Ernest van Dyk [1]; Frederik Vorster [1]

[1] *NMMU*

Corresponding Author: s206029578@nmmu.ac.za

With the rapid deployment of various Photovoltaic (PV) technologies around South Africa, the question has arisen to which technology is best to deploy within certain regions. This paper, discusses the development of a LabVIEW program that employs a meteorological indexing methodology to determine the effect of spectral changes caused by meteorological events on PV module performance. The analysis, using this methodology, was conducted for a subtropical region where the Outdoor Research Facility (ORF) at NMMU is located. The custom-developed LabVIEW program utilises simulated (from Meteonorm) and measured meteorological data to obtain the standard daily irradiance profiles. These profiles are then compared in real time to the measured irradiance obtained from a Silicon CCD spectrometer. With both recorded irradiance and spectral data, 50 W.m-2 resolution bins were created to determine the overall clear sky index, and how it is distributed for a day, week, month, etc. In addition, the measured spectra combined with the spectral response of popular deployed PV technologies can indicate the sensitivity of the technology within these "power" bins. In doing so, the expansion of the metrological index that can be used to determine and forecast the likely performance for each PV technology at different irradiance levels within specific regions of South Africa.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

n/a

**Main supervisor (name and email)
and his / her institution**:

EE van Dyk
Ernest.vanDyk@nmmu.ac.za

Nelson Mandela Metropolitan University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 44 / **155**

Investigating the candidate 5-alpha cluster state at 22.5 MeV with the (p,t) and (p,3He)

Author: Lerato Baloyi[1]

Co-authors: Iyabo Usman [1]; Jacobus Swartz [2]; Jonn Carter [1]; Retief Neveling [3]

[1] *University of the Witwatersrand*

[2] *Department of Physics and Astronomy, Aarhus University, DK-8000 Aarhus C, Denmark*

[3] *Department of Nuclear Physics, iThemba LABS, Somerset West 7129*

Corresponding Author: baloyi.lynah@gmail.com

The study of alpha-cluster (two proton two neutron) in light nuclei have been well documented with experimental evidences. Meanwhile, in the recent experiments performed at iThemba LABS using (p,t) reaction on 22Ne with the K600 magnetic spectrometer, a 22.5 MeV state was found, which accounts for 5-alpha cluster situated at 3.3 MeV above the 5-alpha break-up threshold. However, this state could not be accounted for by theoretical shell-model calculations and angular distribution data taken at forward angles including zero degrees. In the present project, (p,3He) reaction on 22Ne will be carried out at multiple angles, to investigate this state in order to ascertain its spin, parity and isospin. In this case, a proton beam with an energy of Elab= 80 MeV from the Separated Sector Cyclotron (SSC) facility impinged on a 22Ne gas target at lab angles of Θlab= (00, 70, 170, 270) will be considered. Preliminary results of these experiments will be discussed.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Dr. Iyabo Usman
iyabo.usman@wits.ac.za
University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Applied Physics / 156

Readout units and the calibration of load cells.

Author: Sipho Dlamini[1]

[1] *National Metrology Institute of South Africa*

This paper discusses the role of measuring amplifiers commonly known as readout units in force calibration measurements of load cells. The measurement process consists of obtaining the value of a physical quantity (e.g. force) and representing it as a number or in a converted form. Readout units play a critical function of obtaining the signal from the load cell, amplifying, converting, and displaying the output for capture by the user. The readout unit therefore has a significant impact on the force calibration measurement results. In this paper, characteristics such as the resolution and connection cable requirements of readout units in relation to force measurements are discussed. The effects on the readout unit's zero drift due to environmental conditions such as temperature and continuous use over time are also emphasised. The impact of the use of four and six wire configurations as well as cable length between the readout and the load cell is highlighted.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 61 / **157**

Characterization of the spectral irradiance measurement setup

Author: Macdufe Mkabela[1]

Co-authors: Pieter Du Toit [2]; Rheinhardt Sieberhagen [2]

[1] *National Metrology Institution of South Africa*

[2] *NMISA*

Corresponding Author: mmkabela@nmisa.org

This presentation addresses sources of uncertainties in an ultraviolet (UV) spectroradiometry setup for measuring spectral irradiance. In UV spectroradiometry, spectral irradiance measurements have high uncertainties mainly due to a low signal-to-noise ratio (SNR) in the UV region; however other factors may also contribute to high uncertainties. Therefore determining the sources of uncertainties is important to improve the accuracy of the measured results. We perform characterization of the UV spectroradiometric setup to quantify certain sources of uncertainty in measurement associated with this setup. These include positioning and alignment of sources, scattered light, and the system temperature dependence.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Walter Meyer
wmeyer@up.ac.za
University of Pretoria
Private bag X20
Hartfield
0028

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Poster Session 2 - Board: 62 / **158**

Fusion Splicing of Double-Clad Large Mode Area Fibres for Fabrication of High Power Fibre Laser

Author: Mosima Kgomo[1]

Co-authors: Daniel Morris [1]; Lorinda Wu [1]; Wayne Koen [1]

[1] *CSIR National Laser Centre*

Fibre based lasers have become a dominant laser architecture due to high output powers and efficiencies, compact form factors, and excellent beam quality. Double-clad large mode area fibres are required to achieve high output power (up to kW level).

The performance and integrity of an all-fibre laser is critically dependant on the quality of splices between different components constituting a fibre laser. Fusion splicing is the technique used to interconnect fibres and fibre components. Power loss at the splice joints (splice loss) has a deleterious effect on the performance and long-term reliability of high power fibre lasers. Splice losses, caused by poor fusion splices, lead to a decrease in the optical-to-optical efficiency as well as degradation in the beam quality of fibre lasers.

Obtaining low loss fusion splices remains a challenge in the development of fibre lasers. To address this problem, splice loss optimization experiments were conducted to find optimal parameters that can be used to produce low splice losses. Due to the large number of splice parameters, the experimental methodology made use of fractional factorial design which enables the reduction of the required number of experiments by performing them at a certain specific combination of parameters. A system was setup to conduct splice loss measurements. The splice loss results analysed by using a statistical tool called analysis of variance (ANOVA) will be presented.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Dr Lorinda Wu, lwu@csir.co.za,CSIR National Laser Centre

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Space Science / **159**

Observations of meridional and vertical propagation of ionospheric disturbances

Author: John Bosco Habarulema[1]

Co-author: Zama Thobeka Katamzi-Joseph [2]

[1] *South African National Space Agency and Rhodes University*

[2] *South African National Space Agency*

Corresponding Author: jhabarulema@sansa.org.za

Large scale travelling ionospheric disturbances (TIDs) are mainly observed during geomagnetic storms and usually propagate in equatorward direction. They are launched from high latitude regions due to energy injection that enhances Joule heating and Lorentz coupling processes. In this paper, we will show that equatorward TIDs also propagate vertically upwards and influence plasma distribution in the topside ionosphere.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Applied Physics / 160

Determination of the optical behaviour of an explosive charge during detonation in an open air environment

Author: Nomahlubi Thunyiswa[1]

Co-authors: Chris Theron [2]; Marius Olivier [1]; Tleyane Sono [1]

[1] *CSIR*

[2] *University of Pretoria*

Corresponding Author: athunyiswa@csir.co.za

Current military operations occur in built up areas and contains high level of uncertainties due to the uses of improvised explosive devices (IEDs). Because of the current operational theatre and the uncertainties of IEDs, military vehicles have to achieve high level of mobility without compromising the required protections against these threats. One approach to deal with the conflicting requirements between adequate protection and high mobility is to employ detection systems which can aid with avoidance protection or interception of threats. To optimise the effectiveness of the detection system employed for the interception concepts such as active blast protection system, knowledge about the emissions from the explosion processes following detonation is required so that adequate mitigation system can be employed.
The undertaken study focuses on using the light emissions emanating from an explosion of high explosives to understand the origin of the detected optical signature. Preliminary analysis of optical data obtained during previous explosives tests at the CSIR's explosives test range is presented. Optical detector- filter combination of wavelengths ranging from 0.254 μm to 12.2 μm was used to select study light emissions of wavelengths of interest. From the analysis, distinct optical maxima are observed which varies from Ultraviolent (UV) to the Infrared (IR). The UV optical profile contains sharp optical peaks which last for less than a few microseconds while the IR show a slow rising light signal in the millisecond region. The next task is to use light signature to understand and be able to explain what may have caused the signals captured at certain region of the spectrum, the origin of the relationship between amplitude maxima and wavelength.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Professor Chris Theron, chris.theron@up.ac.za, University of Pretoria

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Space Science / 161

On the reduction of drift coefficients in the presence of turbulence

Author: Nicholas Eugene Engelbrecht[1]

Co-authors: Du Toit Strauss [2]; J.A. le Roux [3]; Renier Burger [4]

[1] *Center for Space Research, North West University*

[2] *Centre for Space Research, North-West University*

[3] *Center for Space Plasma and Aeronomic Research, University of Alabama in Huntsville*

[4] *North-West University*

Corresponding Author: n.eugene.engelbrecht@gmail.com

Drift effects have long been known to play a significant role in the transport of charged particles in the heliosphere. A turbulent magnetic field is also known to reduce the effects of particle drifts. The exact nature of this reduction is, however, unclear. This study aims to provide some insight-into this reduction, and proposes a relatively simple, tractable means of modelling it that provides results in reasonable agreement with extant numerical simulations of the drift coefficient in a turbulent magnetic field. Furthermore, we investigate the possible spatial dependences of this new turbulence-reduced drift coefficient in the heliosphere using the results of a turbulence transport model as inputs, along with comparisons with turbulence-reduced drift coefficients proposed in previous studies.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Physics Education / 162

How do undergraduate students respond to early research?

Author: Sondezi Buyi[1]

[1] *University of Johannesburg*

Corresponding Author: bmsondezi@uj.ac.za

Institutions of higher learning particularly at the undergraduate level are driven by strategies used in teaching and learning. Students tend to attribute their performance to the teaching methods used in academic terms. It is this measuring tool they use to determine their learning. In the academic environment where the focus is to get an increased number of students who'll enrol for postgraduate degrees, methods of attracting students to stay longer in the system are sought out timely. In the field of Science especially in Physics department, where student numbers at postgraduate level are normally low, new and innovative methods are necessary to attract and retain students in the system. A study has been conducted where students at the undergraduate level were introduced to the research environment, where the work they were exposed to is highly experimental. At the end of the period, students were required to report back on their experiences. The second part of the study involved the analysis of scientific data obtained from our research lab where students had

to do literature search, which also forced them to consult respective postgraduate students. In this report the responses and observations obtained from the students are reported.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Physics of Condensed Matter and Materials 1 / 163

Structural evolution of tin catalyst heated during x-ray photoelectron spectroscopy

Author: Fortunate Mofao Modiba[1]

Co-authors: CLIVE OLIPHANT [2]; Christopher Arendse [3]; Louise Mostert [2]; sfiso khanyile [1]

[1] *NMISA,UWC*

[2] *NMISA*

[3] *Physics Dept., UWC*

The attractive optical, electrical and mechanical properties of silicon nanowires (SiNWs) are promising for applications within photovoltaic devices. The diameter and length of the SiNWs is crucial in the solar cell application and can be controlled by the metal catalyst nanoparticles size. Due to its lower Si eutectic temperature, tin (Sn) has been identified as a suitable, lower cost alternative to gold (Au) as metal a catalyst employed to synthesize SiNWs. In this contribution, we report on the changes within the microstructure and the chemical bonding environment of a 3 nm Sn thin film heated to different temperatures within an x-ray photoelectron spectroscopy (XPS) system. The thermally evaporated 3 nm Sn thin film on the Si (100) substrate was heated to temperatures of 180, 232, 350 and 450 ℃ on the XPS sample stage. The XPS analysis reveals the presence of metallic Sn and its oxides (SnOx) at room temperature. The carbon (C) peak was also observed, decreasing as the temperatures increases (above 232 ℃) leading to exposure of Sn film. At 350 ℃, the exposure of the Si substrate was detected which can be due Sn content decreases thorough Sn nanoparticle formation or evaporation or infusion. The surface composition and morphology of the heated Sn films displayed an increase in oxidation, particle size and Si, correlating with the XPS results. The increase in the oxidation state of Sn at elevated temperature higher than Si-Sn eutectic (232 ℃)will have implications on the subsequence SiNWs synthesis.

Summary:

The chemical bonding environment of thermally evaporated Sn thin film was investigated in an x-ray photoelectron spectrometer system. The top few layers of the surface consisted of the dominant SnO2 phase, eventually evolving into SnO at temperature higher than 232 ℃. The electron microscopy analysis revealed the surface reconstruction with an increase in temperature.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Dr Oliphant, National metrology institute of South Africa
E-mail address: coliphant@nmisa.org

Prof.Arendse, University of Western Cape
E-mail address: cjarendse@uwc.ac.za,

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Photonics / **164**

Determining the orientation of a radiating dipole through fluorescence microscopy

Author: Ratsimandresy Holinirina Dina Miora[1]

[1] *Laser Research Institute, Sellenbosch University*

Corresponding Author: dina@aims.ac.za

Fluorescence microscopy is an imaging technique capable of resolving very tiny objects which are not within the resolution range of the normal eye. This technique uses the fluorescence properties of the object in order to get direct knowledge of the particle object and indirect knowledge of the substance in which the object is embedded [1]. In our work, a fluorophore is used as a probe object within a thin polymer layer. The emission from the fluorophore is imaged in a 4f-type imaging geometry onto a sensitive sCMOS camera. In order to determine the orientation, a particular phase pattern is loaded onto a spatial light modulator placed at the Fourier plane of the 4f imaging geometry [2]. A given phase pattern enables us to shape the initial electric field into a different one at the image plane. Information about the radiating dipole is then deduced from the intensity pattern of the shaped field. It consists of the orientation and the depth of the emitter, where the orientation is given by the azimuthal and polar angle. Application of this method is widely expanded in biological sciences [3].

References
[1] Backlund MP, Lew MD, Backer AS, Sahl SJ, Grover G, Agrawal A, Piestun R, Moerner WE. Simultaneous, accurate measurement of the 3D position and orientation of single molecules. Proceedings of the National Academy of Sciences. 2012 Nov 20;109(47):19087-92.
[2] Pavani SR, Thompson MA, Biteen JS, Lord SJ, Liu N, Twieg RJ, Piestun R, Moerner WE. Three-dimensional, single-molecule fluorescence imaging beyond the diffraction limit by using a double-helix point spread function. Proceedings of the National Academy of Sciences. 2009 Mar 3;106(9):2995-9.
[3] Backer AS, Moerner WE. Extending single-molecule microscopy using optical Fourier processing. The Journal of Physical Chemistry B. 2014 May 12;118(28):8313-29.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Dr Gurthwin W Bosman (gwb@sun.ac.za)
Department of Physics, Laser Research Institute, Stellenbosch University,South Africa

Prof Erich G Rohwer (egr@sun.ac.za)
Department of Physics, Laser Research Institute, Stellenbosch University,South Africa

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 63 / **165**

Double Helix Point Spread Function, A fluorescence microscopy technique

Author: Ratsimandresy Holinirina Dina Miora[1]

[1] *Laser Research Institute, Stellenbosch University*

Corresponding Author: dina@aims.ac.za

A fluorescence microscopy is an essential tool in the life sciences. In particular, it can be used for tracking a single molecule in a living cell or organic substance such as a polymer. Single molecule trajectory analysis allows an efficient method to explore intermolecular dynamics. Introduction of a technique named double helix point spread function enables accurate localization and orientation determination of a single fluorescent molecule in three dimensions [1]. It consists of changing the phase of the electric field of the emitter in order to make the intensity pattern sensitive to position and orientation [2]. The method uses optical Fourier processing through a 4f imaging system and a modelled phase loaded onto a spatial light modulator placed on the Fourier plane of the 4f imaging pathway [3]. The intensity pattern is changed from the conventional point spread function to a double helix point spread function. In this work, we introduce the phase mask in order to get a double helix point spread function then show results for its usefulness in fluorescence microscopy.

References
[1] Pavani SR, Thompson MA, Biteen JS, Lord SJ, Liu N, Twieg RJ, Piestun R, Moerner WE. Three-dimensional, single-molecule fluorescence imaging beyond the diffraction limit by using a double-helix point spread function. Proceedings of the National Academy of Sciences. 2009 Mar 3;106(9):2995-9.
[2] Roider C, Jesacher A, Bernet S, Ritsch-Marte M. Axial super-localisation using rotating point spread functions shaped by polarisation-dependent phase modulation. Optics express. 2014 Feb 24;22(4):4029-37.
[3] Backer AS, Moerner WE. Extending single-molecule microscopy using optical Fourier processing. The Journal of Physical Chemistry B. 2014 May 12;118(28):8313-29.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Dr Gurthwin W Bosman (gwb@sun.ac.za)
Department of Physics, Laser Research Institute, Stellenbosch University, South Africa

Prof Erich G Rohwer (egr@sun.ac.za)
Department of Physics, Laser Research Institute, Stellenbosch University, South Africa

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Physics Education / **166**

Physics in isiZulu: how far should we go?

Author: Derek Fish[1]

Co-authors: Nancy Pelaez [2]; Saalih Allie [3]; Trevor Anderson [2]

[1] *University of Zululand*

[2] *Purdue University*

[3] *UCT*

Corresponding Author: thefish@iafrica.com

The language of physics instruction has long been an important and controversial topic – especially in South Africa. The author considered this issue in the refinement of a science show presented at Unizulu Science Centre. The show uses music and musical instruments to introduce students to topics around sound and waves. In previous presentations at SAIP conference, the author has reported on an extensive study of this show (conducted towards a masters degree) which measured what students learnt from the show and which revealed difficulties for students coming from rural schools when contrasted with those from urban and township schools. As an extension to this study (conducted towards a doctoral degree) the show was presented to the weaker rural group in isiZulu, while the survey instruments used were kept in English. Significant gains in student confidence and learning were measured, compared with that previously achieved by similar rural groups. While performed in the context of science shows in science centres, this study nevertheless has relevance to all educational interventions in physics. Whatever the challenges, it may be argued that mother-tongue instruction is preferable wherever possible for maximising student understanding and engagement. The implications of these findings for presenting further Physics courses in isiZulu will be outlined for discussion.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Applied Physics / 167

Numerical Modelling of experiments performed at the OPAL research reactor

Author: Rotondwa Mudau[1]

Co-authors: Danniell Botes [1]; Francois Van Heerden [1]

[1] *Necsa*

Corresponding Author: rotondwamda@hotmail.co.za

The IAEA is currently administering an international Coordinated Research Project (CRP), the main purpose of which is to develop a set of research reactor benchmarks for the verification and validation of computational codes. The focus of the CRP in particular is the modelling of multi-cycle

depletion. Necsa has recently developed a new calculational framework for performing nuclear reactor core calculations, which integrates both the stochastic and deterministic modeling methods in a consistent manner. In this work, the system is applied to the OPAL benchmark problem.

The OPAL reactor is a modern research reactor with challenging aspects in neutronic design. In particular, the use of burnable poisons and a heavy water reflector poses modeling challenges. Analysis conducted on this benchmark includes control rod calibration experiments as well as the simulation of seven actual operating cycles.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Nuclear, Particle and Radiation Physics 1 / 168

Gamma-Ray Strength Function in ⁷⁴Ge from the Ratio Method

Authors: Khanyisa Sowazi[1]; Mathis Wiedeking[2]

Co-authors: Aaron Hurst [3]; Andreas Gorgen [4]; Bethany Goldblum [5]; Bongani Kheswa [4]; Darren Bleuel [6]; Jason Burke [7]; Jo Ressler [6]; John Koglin [6]; Lee Bernstein [3]; Lily Crabtree [8]; Maria Petri [3]; Nick Scielzo [6]; Nico Orce [1]; Paul Papka [9]; Robert Hatarik [6]; Stefanos Paschalis [3]; Sunniva Siem [4]; Tim Reed [8]

[1] *University of the Western Cape*

[2] *iThemba LABS*

[3] *Nuclear Science Division, Lawrence Berkeley National Laboratory*

[4] *Department of Physics, University of Oslo*

[5] *Department of Nuclear Engineering, University of California*

[6] *Physical and Life Sciences Directorate, Lawrence Livermore National Laboratory*

[7] *Physical and Life Sciences Directorate, Lawrence Livermore National Laboratory,*

[8] *Department of Nuclear Engineering, University of Tennessee*

[9] *Stellenbosch University*

Corresponding Author: khanyisa.sowazi@gmail.com

An increasing number of experiments reveal the presence of a low-energy enhancement in the gamma-ray strength function (GSF). The GSF, which is the ability of nuclei to absorb and emit &gamma rays, provides insight into the statistical properties of atomic nuclei. For this project the GSF was studied for ⁷⁴Ge which was populated in the reaction ⁷⁴Ge(p,p')⁷⁴Ge at a beam energy of 18MeV. The data were collected with the STARS-LIBERACE array at Lawrence Berkeley National Laboratory. Silicon detector telescopes were used for particle identification and &gamma -rays in coincidence were detected with 5 Clover-type high-purity germanium detectors. Through the analysis particle- &gamma - &gamma coincidence events were constructed. These events, together with well-known energy levels, were used to identify primary &gamma rays from the quasicontinuum. Primary &gamma-rays from a broad excitation energy region, which decay to two 0+ states, six 2+ states, two 3+ states, five 3- states, and four 4+ states, could be identified. These states and the associated primary &gamma -rays are used to measure the GSF for ⁷⁴Ge with the Ratio Method [1], which entails taking ratios of efficiency corrected primary &gamma-ray intensities from the quasicontinuum. I will discuss the results from the analysis of the data from the

above reaction and focus on the existence of the low-energy enhancement in ⁷⁴Ge. The results are further discussed in the context of other work done in ⁷⁴Ge using the (&gamma,&gamma’) [2], (³He,³He’) [3] and (&alpha,&alpha’) [4] reactions.

[1] M. Wiedeking et al., Physical Review Letters 108, 162503 (2012)
[2] R. Massarczyk et al., Physical Review C 92, 044309 (2015)
[3] T. Renstrøm et al., Physical Review C 93, 064302 (2016)
[4] D. Negi et al., Physical Review C 94, 024332 (2016)

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Dr Mathis Wiedeking
wiedeking@tlabs.ac.za
iThemba LABS

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 23 / **169**

Density functional theory study of Ti _n (n = 2-32) clusters: Lowest energy configurations and electronic properties.

Author: Tshegofatso Michael Phaahla[1]

[1] *University of Limpopo*

The geometrical structures and electronic properties of transition metal clusters have been extensively studied during the past decades. However, theoretical investigations on titanium metal clusters have not been carried out systematically up to the larger clusters. In this study, density function theory (DFT) calculations have been performed to investigate the lowest energy structures and electronic properties of Ti_n (n = 2-32) clusters using PBE-Sol spin-unpolarized exchange correlation functional. Most of the previous studies revealed the distorted icosahedral and pentagonal bipyramid geometry as the most stable clusters among the other clusters. Nevertheless, this study predicted that Ti clusters follow the pentagonal behaviour. Triangular bi-pyramid Ti₅ with (D_{3h}) symmetry and pentagonal bi-pyramid Ti₇ with (D_{5h}) symmetry were found to be the most stable clusters compared to their neighbours.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof H. R Chauke
Hr.Chauke@ul.ac.za
University of Limpopo

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Nuclear, Particle and Radiation Physics 1 / 170

Investigation of the isoscalar giant monopole resonance as a function of neutron excess in the 42,44,48Ca isotope chain

Author: Sunday Olorunfunmi[1]

Co-authors: A Tamii [2]; Bernadette Rebeiro [3]; Chane Moodley [4]; Deoin Steyn [5]; ELIAS SIDERAS-HADDAD [4]; Frederick David Smit [5]; Harshna Jivan [4]; Hiro Fujita [2]; Iyabo Usman [6]; J Brummer [7]; John Carter [4]; Kevin Li [8]; Lindsay Donaldson [9]; Luna Pellegri [9]; Marín-Lámbarri Daniel José [10]; N Pietralla [11]; Paul Papka [12]; Pheladi Topsy Molema [4]; Philip Adsley [13]; Retief Neveling [5]; Vincent Pesudo [5]; Y Fujita [14]

[1] *University of the Witwatersrand, South Africa*

[2] *RCNP Osaka*

[3] *University of the Western Cape*

[4] *University of the Witwatersrand*

[5] *iThemba LABS*

[6] *University of the Witwatersrand, Johannesburg.*

[7] *University*

[8] *Stellenbosch University, iThemba Labs*

[9] *University of the Witwatersrand / iThemba LABS*

[10] *University of the Western Cape/ iThemba LABS*

[11] *TU Darmstadt*

[12] *Stellenbosch University*

[13] *University of Stellenbosch/iThemba LABS*

[14] *University of Osaka*

Corresponding Author: sunday.olorunfunmi1@students.wits.ac.za

Study of the Isoscalar Giant Monopole Resonance (ISGMR) provides insight into the incompressibility of the nuclear matter since it has a direct connection with the excitation energy of ISGMR. Nuclear incompressibility is an important quantity in the study of neutron stars and related astrophysics applications. In recent years, isotope dependence of the nuclear incompressibility has been mostly concentrated in heavy nuclei, in particular Sn and Pb isotopes with a limited range of neutron excess, yielding varying results. Therefore, a study of ISGMR in 42,44,48Ca isotopes with a much larger range of neutron excess promises a more precise determination of the nuclear incompressibility. Experiments were performed using the Separated Sector Cyclotron of iThemba LABS, together with the K600 magnetic spectrometer using inelastic scattering of 200 MeV alpha particles at zero degrees from 42,44,48Ca for high energy-resolution measurements in the region of ISGMR. In addition, unique insight into the competition of various damping mechanisms contributing to the decay of the ISGMR can be gained from the extracted energy scales. Following an autocorrelation function analysis, J π = 0+ level densities can also be extracted. Preliminary results will be presented.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Dr. I.T. Usman,
iyabo.usman@wits.ac.za
School of Physics, University of the Witwatersrand, SA

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 24 / **171**

STRUCTURAL AND OPTICAL PROPERTIES OF ZrO2/Zr/ZrO2 MULTILAYERED SELECTIVE SOLAR ABSORBER

Author: Nhlakanipho Wiseman Khoza[1]

Co-author: Malik Maaza [2]

[1] *Unizulu*

[2] *iThemba LABS*

Corresponding Author: nhlakaniphokhozah@gmail.com

Selective solar absorber coatings based on ZrO2/Zr/ZrO2 multilayered coatings were prepared using Dc magnetron sputtering machine onto microscopic glass, silicon wafers and copper substrates. It was found that ZrO2/Zr/ZrO2 multilayered solar absorber coating exhibited a good spectral selectivity of 0.90/ 0.12. The chemical composition and structures were investigated by scanning electron microscop (SEM), x-ray diffraction (XRD) and atomic force microscopy (AFM). The spectral reflectance of the as- deposited coatings were measured by UV-vis-NIR spectrophotometer, 0.25-2.5μm, and thermal emittance spectra were also measured by emmisometer. The multilayered selective solar absorber coatings shows a good prospects for solar absorber because of simple process, low cost, large area and good performance.

Summary:

In this work, the synthesis of the thin films will be done using DC Magnetron sputtering system, because of its high deposition rates, ease of sputtering any metal, high purity film and excellent uniformly on large- area substrates. Zr metallic layer will be deposited onto microscopic glass, Si wafers and Cu substrates.Then ZrO2 layer on top of Zr like making a sandwich. And then another Zr onto ZrO2 layer. Finally ZrO2 will be deposited to complete a multilayered selective solar absorber, hence SiO2 will also be deposited as optional to avoid oxidation. The samples will be characterized using various characterization techniques such as XRD, SEM, EDS, AFM, UV-Vis-NIR spectrophotometer and emissometer.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Prof M. Maaza
email: likmaaz@gmail.com
Nanosciences African Network, Materials Research Department, iThemba LABS, P.O. Box 722, National Research Foundation, South Africa.

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Nuclear, Particle and Radiation Physics 1 / 172

New developments in the nuclear binary cluster-Core in the Super-Heavy Nuclear region

Author: Boniface Dimitri Christel Kimene Kaya[1]

Co-author: Shaun Wyngaaardt [1]

[1] *Stellenbosch University*

The atomic nucleus is a complex many-body interacting system, which exhibits a underlying correlated set of nucleon states. The clustering model is one of the most reliable models that predicts the strongly correlated subsystem of nucleons closed to the threshold decay of nuclei. The binary-cluster model describes the structure and decay properties of super-heavy nuclei.

The phenomenological Cubic Woods-Saxon potential, developed by Buck, Merchant and Perez, has successfully predicted a number of experimental observable s associated with clustering phenomenon. The recently developed microscopic double folded M3Y potential results in the inverted spectra for the positive parity excited cluster states, but successfully predicts the decay half-life for alpha-Pb system. These shortcomings of the M3Y based microscopic binary cluster model lead to the newly developed hybrid code-cluster potential, obtained by fitting the Phenomenological Woods-Saxon Cube and the M3Y double folding at the surface region where the two potential coalesce.

Summary:

The project presented will give an overview of the nuclear cluster models available. Furthermore the recently developed self-consistent relativistic mean-field cluster-core description will be presented.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof Shaun Wyngaardt

Stellenbosch University
Physics Department
Nuclear Group

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 25 / **173**

Influence of partial anionic substitution on luminescence properties of CaMoO₄:Eu³⁺ compounds as solid state LED phosphors.

Authors: Machaba Leanyatsa Abraham Letswalo[1]; Odireleng Martin Ntwaeaborwa[2]

Co-authors: Balakrishna Avula [3]; Hendrik Swart [4]; Leelakrishna Reddy [1]

[1] *University of Johannesburg*

[2] *University of Witwatersrand*

[3] *University of The Free State*

[4] *University of the Free State*

Corresponding Author: leanyatsa.abram@gmail.com

A solid state method was used to prepare CaMoO₄, CaMoO₄:Eu³⁺, CaMoO₄-BO,₃:Eu³⁺,CaMoO₄-PO₄:Eu³⁺ and CaMoO₄-SO₄:Eu³⁺ powder phosphors. X-ray Powder diffraction (XRD), UV-Vis absorption spectroscopy, scanning electron microscopy (SEM) and photoluminescence (PL) spectroscopy were used to characterize the powders. The XRD results indicate that the substitution of anions (BO₃²⁻,PO₄²⁻and SO₄²⁻) and Eu³⁺ dopant ion did not affect the crystal structure of the CaMoO₄ phosphors, but greatly influenced the PL intensities of the CaMoO₄:Eu<sup>3+</ phosphors. The luminescence spectra, excited at 395 nm using a monochromatized xenon lamp, for the four different CaMoO₄:Eu³⁺ phosphors were recorded. The PL spectra showed an intense red emission at 615 nm belonging to the ⁵ D₀ -> ⁷ F₂ electric dipole transition. The highest PL intensity was observed from CaMoO₄-SO₄:Eu³⁺ sample. The decay curves were recorded when monitoring the 615 nm emission. All the decay curves were single exponential and lifetimes remain constant with a value in region of 430 microsecond (μs). The calculated CIE (Commission Internationale de l'Eclairage) confirmed that the emission color was lying in the red region. The PL data suggest that our materials have potential application as source of red light in red light emitting diode.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof O.M Ntwaeaborwa
University of Wits
ntwaeab@gmail.com

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Physics of Condensed Matter and Materials 1 / 174

The structural and sensing properties of cobalt and indium doped zinc oxide nanopowders synthesised through high energy ball milling technique

Author: Mahlatse Manamela[1]

Co-authors: Bonex Mwakikunga [2]; Thuto Mosuang [1]

[1] *University of Limpopo*

[2] *CSIR National Laser Centre*

Corresponding Author: thuto.mosuang@ul.ac.za

The high energy ball milling technique was employed to synthesise the undoped ZnO, 5% Co and In single doped and Co-In double doped ZnO nanoparticles. The x-ray diffraction (XRD) was used to probe the structural properties. It was found that the difraction pattern for In-ZnO nanoparticles display an additional peak which was associated with In+3 dopant. Now, incorparating Co and In

into ZnO nanoparticles resulted in the reduction of the avarage grain sizes. The scanning electron microscopy (SEM) images shows that the nanoparticles have a spherical shape. The kenosistec station equipment was used to characterise the prepared samples for gas sensing application. Ammonia (NH3) gas is being probed in the present work. In all the diffraction patterns observed, the undoped and double doped ZnO nanoparticles are being favoured at a temperature range 200 – 350 ^{o}C.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

TE Mosuang; Thuto.mosuang@ul.ac.za
University of Limpopo

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Space Science / **175**

The effects of a time dependent wavy neutral sheet on cosmic-ray modulation in the heliosphere – progress and challenges

Author: KATLEGO MOLOTO[1]

Co-author: Nicholas Eugene Engelbrecht [2]

[1] *NORTH WEST UNIVERSITY*

[2] *Center for Space Research, North West University*

Corresponding Author: katlego.daniel@gmail.com

The heliospheric magnetic field, originating on the Sun, is frozen into the solar wind due to its high conductivity, and field lines are drawn out into spirals due to the rotation of the Sun. The two hemispheres of the heliosphere with oppositely directed magnetic field are separated by the so-called wavy neutral sheet. It has long been known that gradient- and curvature drift, as well as drift along the wavy neutral sheet, play a key role in cosmic-ray modulation. Previous attempts to numerically model this last effect have relied on a steady state, effective tilt angle approach to describe the neutral sheet. In this work a novel, truly time-dependent neutral sheet is introduced. Preliminary results, as to cosmic ray intensities calculated with a numerical modulation code wherein this new approach is implemented, are presented.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Dr Eugene Engelbrecht
n.eugene.engelbrecht@gmail.com

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Physics of Condensed Matter and Materials 1 / 176

Charge generation from Fullerene Exciton in Low band Gap polymer based solar cells.

Author: Newayemedhin Tegegne[1]

Co-authors: Heinrich Schwoerer [1]; Wendimagegn Mammo [2]; Zelalem Abdissa Abdissa [3]

[1] *Stellenbosch University*

[2] *Addis Ababa University*

[3] *Addis Ababa Univeristy*

Corresponding Author: ntegegne@sun.ac.za

The bulk heterojunction of a donor polymer and fullerene derivatives is common active layer in organic solar cells. The choice of fullerenes plays an important role in the efficiency. The fullerene, [6,6]-phenyl-C71-butylic acid methyl ester (PCBM71) is chosen in many cases over [6,6]-phenyl-C61-butylic acid methyl ester (PCBM61) for its higher absorption in the visible. We investigated the charge dynamics of bulk heterojunction of therthiophene-isoindigo as a donor and two fullerene derivatives PCBM71 or PCBM61 as acceptors using femtosecond-transient absorption spectroscopy. The samples were pumped at 388 nm to effectively pump the fullerene and not the donor polymer.

**Apply to be
 considered for a student
   award (Yes / No)?:**

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

PhD

**Main supervisor (name and email)
and his / her institution:**

Heinrich Schwoerer
heso@sun.ac.za
Stellenbosch University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Physics of Condensed Matter and Materials 1 / 177

 COMPUTATIONAL MODELLING STUDIES OF Fe-Al-X (X= Pt, Ru) ALLOYS

Author: Christine Mkhonto[1]

[1] *University of Limpopo*

Corresponding Author: chrestinah.mkhonto@ul.ac.za

Iron aluminides intermetallic compounds are regarded as promising materials for industrial applications because of their low cost, low density, high temperature strength, as well as excellent oxidation

and corrosion resistance. The Fe-Al based systems have recently attracted a lot of attention as a potential replacement of steel due to their excellent resistance to oxidation at high temperatures, yet limited room temperature ductility and a sharp drop in strength above 600 oC. These intermetallic ordered structures have attracted great interest for both scientific and possible technological applications, mainly based in the stoichiometric compositions of Fe₃ Al and FeAl, have a great potential in a variety of structural application such as Stainless Steel Coatings, automobile and aero-space industry in substitution of superalloys. The study will employ Density functional theory (DFT) to investigate the ground state energies of many-body systems using MedeA (VASP) and Materials Studio (CASTEP code) in order to compute the electronic structure of materials and observing similar and distinctive characteristic and behavioural properties of these alloys at different percentages. The calculated cut-off energy of 500 eV, various number of k-points and geometry optimisation reveals the relaxation and stability behaviour of Fe-Al alloys. Density of states will further describe the interval of energy at each energy level that are available to be occupied At. 0% to 100% wherelse FeAl at. 50% has minimum number of density of states at fermi level in a phase diagram. Phonons will be shown to further elaborate that they are in agreement with the density of states obtained.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof H.R Chauke
hr.chauke@ul.ac.za
University of Limpopo

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Applied Physics / 178

An International Experiment on Atmospheric effects in False Bay, South Africa

Author: Faith February[1]

Co-author: Willem Gunter [1]

[1] *Institute for Maritime Technology*

Corresponding Author: faith_october@yahoo.com

The First European South African Transmission Experiment (FESTER) was conducted in False Bay, South Africa from April 2015 through February 2016. The Institute for Maritime Technology (IMT)in Simon's Town, South Africa collaborated with the Netherlands Research Organisation (TNO), the Fraunhofer Institute for Optronics, System Technologies and Image Exploitation (IOSB), Germany and the Norwegian Defence Research Establishment during the experiment. One of the objectives of the experiment was to characterize the local influence on transmission, refraction and optical turbulence. During the experiment a wide variety of environmental conditions were encountered and several equipment were deployed at different locations in False Bay to quantify the atmospheric effects. Additional measurements were done to determine the steady state and dynamic infrared signatures of maritime targets. An overview of the experiment will be given and some results will be shown.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Nuclear, Particle and Radiation Physics 1 / 179

Efficiency calibration of the laboratory based gamma-ray detector for various sample geometries

Author: Avuyile Sisanda Bulala[1]

Co-authors: Ntombizikhona Ndlovu [2]; Peter Peane Maleka [2]; Saalih Allie [1]

[1] *University of Cape Town*

[2] *iThemba LABS*

Corresponding Author: bulalaavu@gmail.com

Radioactivity has been present on earth since its formation and is part of the environment we live in. Humans are exposed every day to radioactivity through the radioactive elements that occur naturally in the environment. Radionuclides are found naturally in air, water, soil, plants and inside our bodies. The radionuclides we encounter in the environment can be classified into the following three categories; primordial, cosmogenic and anthropogenic (Knoll, 2010). In the study radiometric measurements using various sample containers/holders are performed. Available sample holders under study are marinelli beaker, cylinder (pill bottle) and point source. The gamma-ray spectrometry method is the tool used to analyse samples. For absolute photo peak efficiency measurements IAEA reference material RGU-1, RGTh-1 and potassium chloride powder were prepared for 100 ml pill bottles and the Marinelli beakers (1L) then each measured in HPGe detector for a day. Additionally, certified reference point sources bought from NMISA were also measured. From the known activities of the point sources and the prepared volume sources, photopeak efficiency was calculated and efficiency parameters for these geometries were obtained. The experimentally determined efficiency parameter of various geometries, will therefore be compared with simulated results of similar setups. For this contribution, the efficiency of the detector as function of gamma-ray energy in various measuring geometries will be discussed.

**Apply to be
 considered for a student
   award (Yes / No)?:**

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

MSc

**Main supervisor (name and email)
and his / her institution:**

Prof Saalih Allie, saalih.allie@gmail.com, University of Cape Town.

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Applied Physics / 180

Uncertainty analysis for Positron Emission Particle Tracking (PEPT) measurements

Author: Thomas Leadbeater[1]

Co-authors: Andy Buffler [1]; Kathryn Cole [1]; Michael van Heerden [1]

[1] *University of Cape Town*

Corresponding Author: tleadbeatr@gmail.com

In the technique of Positron Emission Particle Tracking (PEPT), and its equivalent subsets, a single radioactive tracer particle is frequently located as it moves through the system under study. Detection of pairs of annihilation photons emitted by the particle define a line along which the particle is thought to be positioned, and each location is then calculated via a triangulation approach assuming a fixed signal to noise ratio. A contiguous set of locations then define the particle trajectory, and are used to measure the kinematic and dynamic parameters of the particle motion. Often these parameters are further processed to infer the global system behaviour.

Uncertainties are introduced at each stage of the measurement process; of particular note are those driven by the fundamental physics, the detection systems, and the statistical processes used to extract the trajectory from the measured data. Once the uncertainty in each location measurement is defined, the uncertainty budget for the derived quantities typical to a PEPT study can be calculated. Here we present a full analysis of the measurement uncertainty budget and its propagation as applied to PEPT measurements. Typically we can locate a particle moving at 1 m/s at a rate above 1 kHz, to within 0.5 mm (stat) and 0.5 mm (sys) as measured in three dimensions.

**Apply to be
 considered for a student
   award (Yes / No)?:**

no

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

n/a

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

y

Physics of Condensed Matter and Materials 1 / 181

Computational studies of Na/MgMn₂O₄ Spinels.

Author: Ndanduleni Lethole[1]

Co-author: Phuti Ngoepe [1]

[1] *University of Limpopo*

Corresponding Author: lesley.lethole@ul.ac.za

Spinel lithium manganese (II) oxide (IV) (LiMn₂O₄) has been intensively studied as a positive electrode for rechargeable Li-ion batteries due to its abundance in the earth crust, low toxicity, and high theoretical capacity of 148 mAh/g. However this material has been reported to suffer from severe capacity fading, particularly at high temperatures during the charge/discharge process. This drawback makes the material incompetent for commercial application, though many attempts were made to improve its capacity sustainability. Recently, preliminary studies have shown that NaMn₂O₄ and MgMn₂O₄ have great potential for use in Na-ion and Mg-ion batteries. However, little has been reported on the physical and chemical properties of these compounds.

In this work, we perform first principles calculations to investigate the structural, thermodynamic, electronic and mechanical properties of NaMn₂O₄ and MgMn₂O₄, particularly the lattice constants, heats of formations, band structure, density of states, elastic constants and phonon dispersion curves. Furthermore, the operating voltages are also calculated. Calculations have been performed within DFT+U method as implemented in the Vienna Ab initio Simulation Package code. The calculated lattice constants are in good agreement with the experimental data to within 3 %. The electronic DOS and band structure calculations suggest that NaMn₂O₄ and MgMn₂O₄ are conductors due to the absence of energy band gap around the fermi level.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Ngoepe PE,
phuti.ngoepe@ul.ac.za
University of limpopo

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 45 / **182**

Analysis of the 150Sm(4He,2n)152Gd data taken with the AFRODITE spectrometer

Author: ADIVHAHO NETSHIYA[1]

Co-authors: JOHN SCHAFER [1]; TSHEPO DINOKO [2]

[1] *UNIVERSITY OF THE WESTERN CAPE*

[2] *ITHEMBA LABS*

Corresponding Author: adivhaho.n@gmail.com

The detailed spectroscopy of 152Gd has been studied at iThemba Laboratory for Accelerator Based Sciences using the 150Sm(α,2n)152Gd reaction and the AFRODITE gamma-ray spectrometer. The aim is to investigate the E1 transitions between the octupole and the first excited 02+ bands, and also to build previously known decay scheme of 152Gd and extend it with new transitions that have not been observed within the decay scheme of 152Gd or even new bands. We intend to observe in detail the gamma bands with their odd-even signature splitting and to look for structures (gamma bands and octupole negative parity bands) built on the 02+ configurations.

Summary:

Here we are trying to populate the low spins of 152Gd since we were using beam energy of 25mev and to also extend the decay scheme side ways

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Msc

**Main supervisor (name and email)
and his / her institution**:

Name:John Sharpey Schafer
Email:jfss@tlabs.ac.za
Institution:university of the western cape

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Space Science / **183**

Influence of the solar activity on the stratosphere-troposphere exchange in the southern Africa: Wavelet Approach

Author: Nkanyiso Mbatha[1]

[1] *University of Zululand*

Corresponding Author: nkanyisombatha5@gmail.com

Stratosphere–troposphere exchange (STE) plays an important role in atmospheric chemistry as it changes the oxidative capacity of the troposphere and potentially also affects the climate system because ozone and water vapour are potent greenhouse gases. Moreover, the exchange of particles between the stratosphere and the troposphere could lead to an increase of "bad" ozone (tropospheric ozone) and changes in concentrations of "good" ozone (stratospheric ozone). In this study, we investigate the variability of the STE using ERA-Interim reanalysis data set from the European Centre for Medium-Range Weather Forecasts (ECMWF) and a refined version of a previously developed Lagrangian methodology in the context of solar cycle variation. For the purpose of assessing the solar activity, both solar index F10.7 and the sunspot number index R were used. The study employs the methods of assessing statistical significance and confidence intervals of cross-wavelets phase and wavelet coherence to investigate the influence of solar activity in the formation of the STE process.

**Apply to be
 considered for a student
   award (Yes / No)?**:

no

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 85 / **184**

Surveying the influence tests have on students' attitude towards physics and learning of physics

Author: GIDEON STEPHEN BASSAW[1]

Co-author: Mark Herbert Herbert [2]

[1] *UNIVERSITY OF THE WESTERN CAPE*

[2] *University of the Western Cape*

Corresponding Author: gbassaw1@gmail.com

Acquiring Physics knowledge for undergraduates comes with lots of anxiety and apathy on the part of most students. Examinations have a major influence on the approach to studying physics and hence have an effect on the students' performance. Many students may stay away from lectures, however, they will do everything possible to attend tests and examinations. The influence of examinations on students can be used to drive the process of learning physics. This paper reports on a study investigating the influence tests has on students' attitude towards physics and learning of physics in the first year mainstream mechanics module, PHY111, in the Department of Physics at the University of the Western Cape. In this presentation, an overview will be given of how tests are used in the PHY111 module to drive and focus student learning as well as the findings of a survey of the influence tests have on students' attitude towards physics and learning will be presented and discussed.

**Apply to be
 considered for a student
   award (Yes / No)?:**

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

MSc

**Main supervisor (name and email)
and his / her institution:**

Dr Mark Herbert
msherbert@uwc.ac.za
University of the Western Cape

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

yes

Astrophysics / 185

Echo Mapping of Active Galactic Nuclei

Author: Michael Hlabathe[1]

[1] *University of Cape Town and South African Astronomical Observatory*

Corresponding Author: hlabams@gmail.com

Echo mapping of Active Galactic Nuclei (AGNs) measures the time lag between the variable optical continuum from the accretion disk and spectral line emission from the photoionized gas in order to determine the size of the emitting region and subsequently measure the mass of the supermassive black hole from the resulting lag. Currently there is a dearth of galaxies with measured lags in the region about a redshift of z ~ 0.3. What this project aims to achieve is to measure the lags of galaxies around z ~ 0.3 using observations from South African Large Telescope and Las Cumbres Observatory. Cross-correlation is a method used to measure the time lag between the continuum and line-emission. In this talk, we discuss our implementation of the cross-correlation based on the interpolation cross-correlation function method and its application to real data.

**Apply to be
 considered for a student
   award (Yes / No)?:**

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

PhD

**Main supervisor (name and email)
and his / her institution:**

Dr Encarni Romero Colmenero
erc@salt.ac.za
South African Astronomical Observatory

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Applied Physics / **186**

A new D-T neutron facility at UCT

Author: Tanya Hutton[1]

Co-author: Andy Buffler [1]

[1] *University of Cape Town*

Corresponding Author: tanya.hutton@uct.ac.za

The Department of Physics at the University of Cape Town has recently installed a new fast neutron facility featuring a Sealed Tube Neutron Generator (STNG) to be used for applied nuclear physics research and education. The MP-320 neutron generator utilises a 90 kV accelerated deuteron beam impinging upon a tritium target, producing 14 MeV neutrons via the t(d,n)α reaction. Ultimately we will offer a reference facility with fully characterized neutron energy spectra, yield, and calibrated reference detectors. The potential use for such a facility is wide ranging, from nuclear data measurements to elemental analyses to detector development and calibration. We present the design, building, and commissioning of this facility and propose the future uses. We present data for the radiation dosimetry and shielding for our facility, and initial characterization using a calibrated scintillation detector.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Poster Session 2 - Board: 64 / **187**

Simulating Real Space Changes in Cu(DCNQI)₂ Using Ultrafast Electron Diffraction Data

Author: Bart Smit[1]

Co-authors: Heinrich Schwoerer [1]; Nancy Payne [1]

[1] *Stellenbosch University*

Corresponding Author: absmit@sun.ac.za

Well-established X-ray crystallography techniques allow for full steady-state structural analysis of unknown samples. Ultrafast Electron Diffraction (UED) has the added advantage of being able to look at structural properties of samples upon photoexcitation as a function of time, with sub-picosecond temporal resolution. While combining sensitivity to molecular structure with ultrafast timescales is a powerful tool to study ultrafast structural properties of crystals, UED is unable to determine structures like a 'real' crystallographer can. The lack of many observable diffraction orders and the absence of phase information in the electron diffraction patterns, somewhat limits the structural properties extractable from experimental data. This poster discusses how, by utilising prior structural knowledge obtained by steady-state crystallography, it is still possible to obtain real space information about electron diffraction patterns obtained with UED.

Our UED study is done on the organic radical ion salt Copper Methyl,Bromide-Dicyanochino-Diimine, abbreviated as Cu(Me,Br-DCNQI)₂. When this one dimensionally conducting crystal is cooled, it undergoes a structural phase transition at 155 K, whereby three crystal layers trimerise and the material becomes an insulator. This transition can also be photo-induced, making the sample a suitable candidate for UED studies.

During cooling of the sample, the tetrahedral geometry of the crystal distorts, causing the material to undergo the transition. The distortion parameters (i.e. how does the tetrahedral change shape upon cooling) are determined in previous X-ray studies. Using this knowledge, we attempt to interpret observed intensity shifts in our UED data by computationally simulating electron diffraction patterns from known structure files. The ultimate goal of combining electron diffraction simulation studies with experimental UED data is to fully reconstruct real-space changes in Cu(Me,Br-DCNQI)₂ as it undergoes the photo-induced phase transition, as a function of time, thereby creating a 'molecular movie'.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. dr Heinrich Schwoerer
heso@sun.ac.za
Stellenbosch University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Physics Education / 188

Quantum Key Distribution for The Undergraduate Curriculum

Author: Samukelisiwe Phehlukwayo[1]

Co-authors: Francesco Petruccione [2]; Yaseera Ismail [2]

[1] *University of Kwazulu-Natal*

[2] *UKZN*

Corresponding Author: samke.phehlukwayo@gmail.com

Quantum Key Distribution (QKD) is a process of transferring a secure key between two authorized parties. The key is then used to encrypt confidential information [1]. A communication can be achieved and proven secure through laws of quantum mechanics [1, 2]. The QKD scheme is based on transferring quantum carriers, in the form of single photons, through a quantum channel which can be either free-space or fiber optics [3, 4]. Various protocols exist for the implementation of the key distribution process, with BB84 being the most fundamental of protocols [1]. Here, we present the implementation of the QKD process using fiber optics as the quantum channel. We utilized the commercially available id 3000 clavis system and performed the BB84 and the SARG04 protocols [5] . In our setup, communication was implemented over a distance of 12 km. We characterized the system, id 3000 clavis, and constructed a comprehensive manual which will be useful to undergraduate students and researchers.

References
1. Gisin, N., et al., Quantum cryptography. REVIEWS OF MODERN PHYSICS, 2002. 74(1): p. 145 - 195.
2. Griffiths, D.J., Introduction to quantum mechanics. 2016: Cambridge University Press.
3. Hughes, R.J., et al., Practical free-space quantum key distribution over 10 km in daylight and at night. New journal of physics, 2002. 4(1): p. 43.
4. Gobby, C., Z. Yuan, and A. Shields, Quantum key distribution over 122 km of standard telecom fiber. Applied Physics Letters, 2004. 84(19): p. 3762-3764.
5. Stucki, D., et al., Quantum key distribution over 67 km with a plug&play system. New Journal of Physics, 2002. 4(1): p. 41.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof. Francesco Pretruccione
Email: Petruccione@ukzn.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Nuclear, Particle and Radiation Physics 2 / 189

The impact of an extended Inner Detector tracker on the <i>W<sup>&plusmn measurement in <i>pp</i> collisions at the High-Luminosity LHC with the upgraded ATLAS detector

Author: Raynette van Tonder[1]

Co-authors: Claire Lee [2]; Sahal Yacoob [1]

[1] *University of Cape Town*

[2] *Brookhaven National Laboratory*

Corresponding Author: vtnray001@myuct.ac.za

Vector Boson Scattering (VBS) has been identified as a promising process to study the nature of electroweak symmetry breaking. The best channel for VBS measurements is same-electric-charge W boson scattering: a rare Standard Model process that has a distinctive experimental signature of a same-electric-charge lepton pair and two high energy forward jets. The study of the electroweak production mechanism of <i>W[±]W[±]jj</i> scattering will continue through to the High-Luminosity Large Hadron Collider (HL-LHC) physics program. During this program, the HL-LHC will not only operate at an increased centre of mass energy of 14 TeV, but also produce an instantaneous luminosity of L = 7 × 10³⁴ cm⁻²s⁻¹. Several

upgrades of various sub-detectors of the ATLAS detector are scheduled to cope with the intense radiation and the high pileup environment. The prospects for a <i>W[±]W[±]jj</i> measurement after the LHC and ATLAS detector upgrades will be discussed, with a focus on the impact of an extended tracking detector. The effect of the upgraded Inner Detector on the measurement for the same-electric-charge <i>W[±]W[±]</i> scattering process is evaluated by analysing simulated events with two leptons of the same electric charge, at least two jets and missing transverse energy.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Dr. Sahal Yacoob, sahal.yacoob@uct.ac.za, University of Cape Town

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Physics of Condensed Matter and Materials 1 / 190

Verification of phase transformation temperatures of 9%Cr ferritic steel using dilatometry and neutron powder diffraction

Author: zeldah sentsho[1]

Co-authors: Andrew Venter [2]; Johan DeVilliers [3]; Pieter Pistorius [3]

[1] *necsa*

[2] *Necsa Limited*

[3] *Department of Materials Science and Metallurgical Engineering, University of Pretoria*

Corresponding Author: zeldah.sentsho@necsa.co.za

Creep strength enhanced ferritic steels [1] are used in the manufacture of critical pressure components and vessels in modern power industry due to high thermal conductivity, low thermal expansion, high strength and resistance to creep at elevated temperatures. 9%Cr steel [2] is of technological relevance since it contains elements which provide precipitation strengthening by forming M23C6 carbides and niobium containing carbonitrides. As for many other steels that have a ferritic structure at room temperature, a number of phase transformations occur in 9%Cr steels on heating. At the so-called Ac1 temperature, about 800℃, the transformation of ferrite to austenite begins. At the Ac3 temperature the structure is fully austenitic. On further heating, the transformation of austenite to delta ferrite occurs, at about 1390℃ [3].

Phase transformation temperatures are traditionally established with dilatometry measurements [4] with the onset and progress of transformations inferred from changes in the slope of a graph of sample length vs temperature. The change in slope is in the first instance due to the phase transformation of the bcc ferrite structure to fcc austenite. Notwithstanding dilatometry being sensitive for revealing the consequences of phase transformations, it remains an indirect measure of the onset of phase transformation. If phase transformation results in a dual phase structure with approximately constant volume fractions, the dilatometric curve will show an approximately constant slope. Such a slope can, incorrectly, be interpreted as indicative of a single phase structure.

By using the capability of thermal neutron diffraction [5] as direct probe of crystallographic phase changes averaged over the volume of the sample, in conjunction with in-situ heating, direct quantification of the respective phases through the application of the Rietveld method is possible at a range

of temperatures. In addition, by doing neutron diffraction at pre-determined sample temperatures, an alternative method exists for compiling/verifying phase transformation temperatures. The completion of transformation is better defined with neutron powder diffraction and also the study of the austenite to delta ferrite transformation at about 1300℃ is possible. Preliminary results of the heat treatments conducted at Necsa indicate the range of temperatures for the beginning and end of the transformation of ferrite to austenite on heating. Results from both approaches will be compared and discussed.

Summary:

The following references were used in the write up of this abstract:
[1] B. Lun Wang, J. C. Lippold, and A. S. Sudarsanam Babu, “Development of Predictive Formulae for the A 1 Temperature in Creep Strength Enhanced Ferritic Steels,” The Ohio State University, 2010.
[2] J. Parker, “EPRI Project Manager Guidelines and Specifications for High- Reliability Fossil Power Plants Best Practice Guideline for Manufacturing and Construction of Grade 91 Steel Components discaimaer of warranties and limitation of liabilities,” 2011.
[3] D. J. Abson and J. S. Rothwell, “Review of type IV cracking of weldments in 9–12%Cr creep strength enhanced ferritic steels,” Int. Mater. Rev., vol. 58, no. 8, pp. 437–473, 2013.
[4] K. W. Andrew, “Empirical Formulae for the Calculation of Some Transformation Temperatures,” J. Iron Steel Inst., vol. 203, pp. 721–727, 1965.
[5] S. C. Vogel, “A Review of Neutron Scattering Application to Nuclear Materials,” ISRN Mater. Sci., pp. 1–24, 2013.
Key words: Ferritic steel, Phase transformation, Dilatometry, Neutron powder diffraction

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 26 / **191**

Green synthesis of ZnO nanoparticles and the investigation of their physical properties

Author: Takalani Nethavhanani[1]

Co-authors: Abdoulaye Diallo [2]; Reginaldt Madjoe [1]

[1] *University of the Western Cape*

[2] *iThemba LABS*

Corresponding Author: nethavhananit@yahoo.com

ZnO is a wide band-gap semiconductor “˜3.7 eV” at room temperature with a wurtzite crystal structure. It has attracted a significant interest worldwide above its initial potentiality as the ideal candidate for blue-UV light emitting diodes applications. Its multifunctionality as a transparent conducting oxide, effective piezoelectric, a selective gas sensor and an efficient catalyst support among others, has made it as one of the most studied simple oxide in its nano form in the modern era.
Nano-scaled ZnO has been synthesized in a plethora of shapes. A rich variety of physical and chemical methodologies were used to synthesize undoped or doped ZnO. The synthesis of ZnO nanoparticles by conventional physical and chemical methods has been reported to have adverse effects such as critical conditions of temperature and pressure, expensive chemicals, long reflux time of reaction and toxic byproducts. The green synthesis approaches which are based on using biogenic processes, reduce the pollution risk at source level and hence avoids the waste products that need to be treated or cleaned up after it has been formed.

This work reports on the synthesis and the main physical properties of nano-scaled pure ZnO particles synthesized by a completely green process using Aspalathus Linearis' natural extract of as an effective chelating agent without addition of any acidic or basic medium.

Summary:

Zinc oxide (ZnO) nanoparticles were 'green' synthesized by using the natural extract of Aspalathus Linearis as a chelating agent to reduce the Zn metal salt. Following this, the physical properties of the ZnO nanoparticles were studied using different characterization techniques such as XRD, HRTEM, SEM, FTIR and DSC/TGA.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof. Malik Maaza, maaza@tlabs.ac.za, iThemba LABS

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Theoretical and Computational Physics 1 / 192

Analysis of a heavy boson of mass around 270 GeV in Left-Right Symmetric Models

Author: Amir Abouelrous[1]

Co-author: Bruce Mellado [1]

[1] *University of the Witwatersrand*

Corresponding Author: amirmabouelrous@gmail.com

After the discovery of the Higgs boson by the experiments at the LHC, the search for new bosons has become of great interest. Based on a number of features of the data, the existence of a heavy boson with a mass around 270 GeV has been postulated with a number of interactions. One interesting extension of the Standard Model is the Left-Right Symmetric Models (LRSM). Among the interesting features of the LRSM is their complex Higgs sector. Unlike the SM with only one neutral Higgs Boson, LRSM offers a variety of Higgs Bosons which include neutral, singly charged and doubly charged Higgs Bosons. Due to the Flavour Changing Neutral Currents (FCNCs) constraints, the neutral Bosons of the bi-doublet sector are constrained to be at least 10 TeV. One way to suppress the FCNCs effect is by imposing a global symmetry on LRSM Lagrangian. We analyse the possibility of suppressing the FCNCs effects in the LRSM and determine the possibility of having a heavy neutral Higgs Boson of mass around 270 GeV in the Higgs sector of the LRSM.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof. Bruce Mellado Garcia (Bruce.Mellado.Garcia@cern.ch)/ University of Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 27 / **193**

Green synthesis of Europium oxide Nanoparticles by <i>Hibiscus sabdariffa</i> flower extract: Main physical and optical properties

Author: zamavezi Kweyama[1]

Co-authors: Betty Kibirige [2]; Malek Maaza [1]; Ntevhe Thovhogi [1]

[1] *iThemba LABS*

[2] *University of Zululand*

Corresponding Author: zamavezikwym92@gmail.com

This contribution reports on the synthesis and the main physical properties of Europium (III) oxide (Eu₂O₃) nanocrystals synthesized for the first time by a completely green physical-chemistry process using Hibiscus sabdariffa flower natural extract as an effective chelating agent. Eu2O3 nanoparticles synthesized via green chemistry process would be beneficial for the development of nontoxic, clean and environmentally friendly biosynthesis procedure. The structural and optical properties of such biosynthesis nanocrystals were analyzed by High Resolution Transmission Electron Microscopy (HRTEM), Scanning Electron Microscopy (SEM) showed the images of small NPs formed, from this it was established that the Eu₂O₃ NPs are nano-scaled with a mixed population of crystalline particles, Electron Dispersive X-rays Spectroscopy (EDS), X-Rays Diffraction (XRD) where the grain size of nanoparticles was calculated using Debye-Scherrer approximation and ranged within 14 nm to 25 nm and the calculated lattice constant using the relation was found to be a_{exp}=10.87812 Å which was slightly larger than the bulk value, Fourier Transform Infrared Spectroscopy (FT-IR), Raman, Ultraviolet and visible spectrometer (UV-Vis-NIR) as well as room temperature photoluminescence (PL). The luminescence properties of such cubic were characterized by an intense red emission centered at 614.8 nm (⁵D₀-⁷F₃).

These results represent an important step forward in investigating and determining the properties of Eu2O3 nanoparticles synthesized via green chemistry process. It is a promising cost-effective path and energy wise non-consuming with zero waste end products for highly stable and well-characterized nanoparticles.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Professor Malek Maaza
likmaaz@gmail.com
iThemba LABS

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Nuclear, Particle and Radiation Physics 1 / 194

Injection Line Studies for the SPC2 Cyclotron at iThemba LABS

Author: fhumulani nemulodi[1]

Co-authors: D. T. Fourie [1]; J. I. Broodryk [1]; J. J. Yang [2]; Joele Mira [1]; John Garrett de Villiers [1]; Lowry Conradie [3]; M. J. van Niekerk [1]; R. W. Thomae [1]; T. J. Zhang [2]; W. Duckitt [1]

[1] *iThemba LABS*

[2] *CIAE*

[3] *Member*

Corresponding Author: fnemulodi@yahoo.com

The transmission efficiency of some ion beams through the second solid-pole injector cyclotron (SPC2) at iThemba LABS requires improvement. In order to understand the beam optics in the injection line, and match the beam to the acceptance of the cyclotron, the beam envelope behavior from the beginning of injection-line to the inside of the SPC2 cyclotron was investigated with different simulation programs. The transverse effects were taken into account by the beam transport codes TRANSOPTR and TRANSPORT, while the multi particle simulation code OPAL was used to include space-charge effects. Simulations of the effect of an additional buncher, operating at the second harmonic, on the transmission of the beam of charged particles through the cyclotron were made.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

NO

Physics Education / 195

Students' explanations of motion in real-life context

Author: Paul Molefe[1]

Co-author: Mphiriseni Khwanda [2]

[1] *University of Johannesburg*

[2] *Universtity of Johannesburg*

Corresponding Author: pmolefe@uj.ac.za

The concepts of force and acceleration are crucial when motion in both one and two dimensions is described. The relationship between the two concepts were explained in terms of Newton's first and second law of motion which is included in both high school and university first year physics curriculum. It is expected that both high school and university first year Physics students can be able to explain motion in real- life context in terms of terminologies used in Newton's first and second law. The paper present students' explanation of motion after viewing Phet simulations. Preliminary results revealed some discrepancy in students understanding of both Newtons first and second law.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Nuclear, Particle and Radiation Physics 1 / 196

The Isovector Giant Dipole Resonance in the transition region of the samarium isotope chain

Author: Lindsay Donaldson[1]

Co-authors: Frederick David Smit [2]; J Brummer [3]; Kevin Li [4]; Luna Pellegri [5]; Retief Neveling [2]

[1] *iThemba Laboratory for Accelerator Based Sciences*

[2] *iThemba LABS*

[3] *University*

[4] *Stellenbosch University, iThemba Labs*

[5] *University of Witwatersrand and iThemba LABs*

Corresponding Author: lindsay.donaldson18@gmail.com

The shape transition of the Isovector Giant Dipole Resonance (IVGDR) from the spherical ¹⁴²Nd to the deformed ¹⁵⁰Nd nuclei in the even-even ¹⁴²⁻¹⁵⁰Nd chain has been established using proton inelastic scattering at zero degrees. Comparisons were made to previous photo-absorption results and some discrepancies were found which have implications for astrophysical applications (PLB in preparation). In addition, ¹⁵²Sm was measured to allow for comparisons to its isotone, ¹⁵⁰Nd, to be made. These results will be discussed along with the proposal to perform a coincidence measurement of the IVGDR in ¹⁵⁴Sm via proton inelastic scattering and the observation of the subsequent γ-ray decays with BaGeL (Bagel Array of Ge and LaBr detectors). The ¹⁵⁴Sm data in addition to ¹⁵⁰Sm and ¹⁵²Sm data from a previous experiment will provide insight into the transition region of the samarium isotope chain and will provide an opportunity to test the equivalent virtual photon method in this region.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

197

Coupling of single proton configurations to collective core excitations in ¹⁶²Yb: the nucleus ¹⁶¹Tm

Author: Sandile Jongile[1]

Co-authors: John Sharpey-Schafer [2]; Linda Mdletshe [1]; MAKUHANE SITHOLE [2]; Sifiso Ntshangase [1]; Siyabonga Majola [3]; Tshepo Dinoko [4]

[1] *University of Zululand*

[2] *University of the Western Cape*

[3] *Ithemba LABS*

[4] *iThemba LABS*

Corresponding Author: sandilejongile@gmail.com

Over the past two decades there has been controversy as to whether deformed nuclei are subject to quadrupole vibrations (γ and β), particularly the β vibrations. Pertaining the gamma(K=2⁺) vibrations, experimental evidence has been more or less consistent, confirming they indeed exist. On the other hand the situation remains elusive for the β vibrations which are characterized by the first low lying 0+ excited state. The current study seeks to get more insight on the microscopic nature of the aforementioned by studying the nucleus 161 Tm, which was populate using the ¹⁵²Sm(¹⁴N,5n)¹⁶¹Tm reaction with the aid of the AFRODITE array at iThemba LABS. A level scheme was built for ¹⁶¹Tm by examining multiple gates using coincidence spectra. Transitions were confirmed with DCO (Direct Correlations for Oriented states) and/or polarization anisotropy measurements where applicable. Alignments and band crossings have been used to meaningfully describe the quantum behavior of the collective structures observed in this work. In addition systematic comparisons have also been used to further understand the structural behavior of band structures observed in the level scheme. Furthermore experimental B(M1)/B(E2) values for bands involving the [505]11/2⁻ orbital and other observed strong coupled bands
were obtained to confirm quasi-particle configurations.

This work is supported by the National Research Foundation of South
Africa

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof John Sharpey Schafer
jffs@tlabs.ac.za
University of the Western Cape

Dr S. S. Ntshangase
ntshangases@unizulu.ac.za
University of Zululand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 77 / **198**

How quantum is bird migration: A review.

Author: Betony Adams[1]

Co-authors: Francesco Petruccione [1]; Ilya Sinayskiy [2]

[1] *UKZN*

[2] *University of KwaZulu-Natal and National Institute for Theoretical Physics*

Corresponding Author: betony@gmail.com

Quantum biology, despite scepticism regarding the application of quantum physics to the warm, wet and messy environments of biological systems, is by now a well-established field of research. Two of the predominant topics of this research are photosynthesis and avian magnetoreception. However, while there has been some conclusive experimental evidence that photosynthesis employs quantum effects it is still debatable that birds use quantum mechanics to navigate. This presentation will explore the extent to which avian magnetoreception might be considered a quantum phenomenon. It has been hypothesised that birds employ a radical pair mechanism to negotiate the earth's magnetic field. The hypothesis is supported by the fact that the avian compass is a light dependent, inclination compass. It has been shown that it is structurally possible for a molecule in the eye of the bird to be measurably effected by the weak geomagnetic field. Progress has also been made into the details of the mechanism by identifying a possible molecule, cryptochrome, in which the effect occurs. Cryptochromes in fruit-flies have been demonstrated to mediate magnetic responses. Four different types of cryptochrome have also been confirmed in the eyes of migratory birds while cryptochromes from migratory garden warblers form radicals with millisecond lifetimes under the influence of the blue spectral range. Recent experiments have also demonstrated that the avian compass is disrupted by low intensity anthropogenic electromagnetic radiation across a broad range of radio frequencies. Current theoretical approaches suggest that this could be explained by a quantum needle effect which would further confirm that avian magnetoreception belongs in the category of quantum biology.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Professor Francesco Petruccione

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Physics of Condensed Matter and Materials 1 / 199

First-principles study of <i>graphane</i> with <i>3d</i> transition-metal adatoms

Author: Mahlaga Molepo[1]

Co-author: Enrico Lombardi [2]

[1] *University of South Africa*

[2] *UNISA*

Recently, it has been established that the electronic properties of a <i>graphane</i> (hydrogenated graphene) sheet can be well tuned by foreign atom substitutions. This suggests that incorporating magnetic elements into its semiconducting environment could make <i>graphane</i> a good base for creating low dimensional dilute magnetic semiconductors for spintronic devices desirable for information storage and processing. Using DFT including the GGA + Hubbard U correction, we investigate the effects on structural, electronic and magnetic properties of <i>graphane</i> upon incorporation of <i>3d</i> transition metal (Cr, Mn and Fe) <i>adatoms</i> on different adsorption sites. It is found that the high-spin configurations are more favourable for all the considered systems

regardless of the adsorption sites. The hydrogen-vacancy substitutional site is found to be the most favourable for the adsorption of Cr and Fe, resulting in half metallic magnetic ground states with supercell magnetic moments of 5 μB and 3 μB respectively. On the contrary, the Mn <i>adatom</i> shows appreciable preference to adsorb on the top of a carbon atom, with large magnetic moment of 5 μB.
The observed half metallicity and the rich magnetic properties of these systems are particularly important for efficient spin injection and transport of high spin polarized currents, desirable in spintronic device applications.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Poster Session 1 - Board: 55 / **200**

Developing a method to quantify material density from volumetric data with micro-focus X-ray tomography.

Author: Jakobus Hoffman[1]

Co-author: Frikkie De Beer [1]

[1] *Necsa*

Corresponding Author: jakobus.hoffman@necsa.co.za

Density information is crucial in optimizing industrial important processes such as coal processing and there are a plethora of methods to obtain this information. One such accepted method is float-and-sink analysis during the modelling of coal washability which is expensive, time consuming and environmentally hazardous. The density information obtained is also not in real-time and consequently some inaccuracies are inevitable. Image analysis for coal washability modelling from basic unprocessed rock-face photographs is a technique that enjoys significant research investment due to the speed and ease of obtaining modelling data using only a camera. It is debatable how well the image analysis modelling approximates the reality of a complex and heterogeneous coal seam and thus requires verification with alternate reliable techniques such as micro-focus X-ray tomography. X-ray imaging is based on the X-ray absorption properties of materials having different densities. However, for 3D tomographic analysis a complete density analysis is difficult and requires extensive post-processing. This presentation describes a method using micro-focus X-ray tomography to validate mineral density results obtained from image analysis modelling of photographs of rock faces. This method consist of a calibration technique that accurately connects mineral densities with X-ray absorption images. For future work 3D Micro XCT results will be compared to conventional float-and-sink analysis.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Applied Physics / 201

Lazarus and Fortran for Africhino Quasi-Computer

Author: Marco Mariola[1]

Co-authors: Clinton Bemont [2]; Francesco Petruccione [3]

[1] *University of kwazulu-natal*

[2] *SAIMM, ECSA*

[3] *UKZN*

Micro-computer and micro-controller Open Source devices are often used to perform experiments in the science field. According to recent publications, the most used platforms are the Arduino Micro-controller board and the RaspberryPi micro-computer[1].
Africhino represents an alternative to the aforementioned devices, designed around the exigency of the researchers [2]. Africhino Quasi-Computer (AQC) is a portable laboratory tool, which contains the most necessary instruments to design and testing electronic devices and experimental data measurements. The peripherals of AQC are controlled through a Linux based RaspberryPi or other Open-Hardware micro-computer.
Usually to produce data plotting programs and serial communication between the micro-computer and external devices python is used. Python has an extended mathematical library for data elaboration. Python is an interpreted program language and any no intrinsic mathematical model require more time to be executed [3].
In this work we shown that Lazarus and Fortran can be used as alternative to Python on Open Source Devices. Both Lazarus and the well know Fortran are compiled program languages. Lazarus and Fortran complement each other. Using Lazarus, data plotting and Graphical User Interfaces are easy implementable. Fortran has an extensive mathematical library.
In this research Lazarus and Fortran are linked by using the Shared Object (so) to obtain an optimised code to acquire value from the external peripherals and data elaboration. The performance of Lazarus-Fortran versus Python is tested on thermal transmission system. For each temperature field acquired, an algorithm predicts the internal temperatures of the body. For this study the algorithm for Lazarus-Fortran is the same used for Python, and no intrinsic functions are used.

[1] D Cressey, Age of Arduino, Nature, Vol. 522, pp. 125-125, 6 April 2017
[2] M Mariola and F Petruccione, Open-Source electronic board designed in South Africa for Africa, in The Proceedings of the 60th Annual Conference of the South African Institute of Physics (SAIP2015), edited by Makaiko Chithambo (RU) and André Venter (NMMU) (2015), pp. 457 - 62. ISBN: 978-0-620-70714-5 Available online at http://events.saip.org.za
[3] Comparing Python, NumPy, Matlab, Fortran, etc., URL: https://modelingguru.nasa.gov/docs/DOC-1762

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Physics of Condensed Matter and Materials 1 / 202

Critical behaviour at paramagnetic to ferromagnetic phase transition in Nd2Pt2In

Author: Moise Tchoula Tchokonte[1]

Co-authors: Amal Bashir [1]; Andre Strydom [2]; Buyisiwe Sondezi [2]; Dariusz Kaczorowski [3]; Jean Jules Mboukam [1]; Mamesh Kumar [2]

[1] *University of the Western Cape*

[2] *University of Johannesburg*

[3] *Institute of Low Temperature and Structure Research, Polish Academic of Sciences, Wroclaw, Poland*

Corresponding Author: mtchokonte@uwc.ac.za

The critical behaviour at the paramagnetic to ferromagnetic phase transition in Nd2Pt2In compound has been investigated by means of magnetization measurements using various techniques such as the modified Arrott − plot, the Kouvel − Fisher plot and the critical isotherm analysis. Still the nature of the ferromagnetic transition is found to be of the second − order, the obtained values of the critical exponents, &beta = 0.346(8), &gamma = 1.3548(7) and &delta = 4.14(4) are close to those predicted theoretically by the 3D − Heisenberg model (&beta = 0.365, &gamma = 1.386 and &delta = 4.8). Furthermore the scaling relations are obeyed indicating renormalization of interactions around the Curie temperature TC.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Main supervisor (name and email)
and his / her institution**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Photonics / **203**

Experimental Study of the Weak Field Zeeman Spectra of Rb 85 and Rb 87

Author: Adrian Wyngaard[1]

Co-authors: Christine Steenkamp [2]; Gerhard de Jager [3]; Kessie Govender [1]

[1] *Cape Peninsula University of Technology*

[2] *University of Stellenbosch*

[3] *University of Cape Town*

Corresponding Author: adywyngaard@gmail.com

We report on the measurement and analysis of the magnetic sub-levels of Rubidium 85 and 87 observed in the presence of a weak magnetic field. Included is the standard hyperfine interaction which is a prerequisite measurement for this analysis. The experiment was performed using a saturated absorption spectroscopy setup. A solenoid was placed around the Rb vapour cell in order to generate the magnetic field, and the polarisation of the light was manipulated in order to observe the relevant magnetic sub-levels. This experiment is part of an effort to cool Rb atoms using lasers that need to

be frequency locked to a specific energy level in the spectra observed via the saturated absorption spectroscopy setup.

An external cavity diode laser was frequency modulated and split into three beams, two weak probe beams and a strong pump beam; the pump beam counter-propagates and overlaps one of the probe beams. These beams are sent through a rubidium vapour cell where a magnetic field was applied. A portion of the modulated laser beam was analysed using a Michelson interferometer. Intensities of the probe beams and the output beam of the interferometer were monitored by photodetectors and the output signals were recorded using a digital oscilloscope.

The time axis of each oscilloscope capture was converted to frequency using a calibration factor determined by analysing the output signal of the Michelson interferometer. The converted spectra were fitted with Lorentzian curves to estimate energy level separation and lifetimes, and the magnetic sub-level separation was plotted as a function of the magnetic field strength. A comparison with numerical analysis is also provided.

Summary:

We report on the measurement and analysis of the magnetic sub-levels of Rubidium 85 and 87 observed in the presence of a weak magnetic field.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MEng

**Main supervisor (name and email)
and his / her institution**:

Dr. Kessie Govender, govenderk@cput.ac.za, Cape Peninsula University of Technology.

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 28 / **204**

The effect of thiol collectors on nickel-rich (110) pentlandite surface

Author: Peace Mkhonto[1]

Co-author: Hasani Chauke [1]

[1] *University of Limpopo*

<i>Ab-initio</i> density functional theory was employed to investigate the interaction of thiol collectors on the nickel-rich pentlandite Fe₄Ni₅S₈ (110) surface, in order to establish an insight into the collecting performances of SEX, SIBX and DEDTP collectors during flotation. The HOMO and LUMO energies of the three collectors were computed from DMol³ and revealed that SIBX had the strongest ability to donate electrons, while DEDTP accept electrons. We observed that the collecting strength of DEDTP on the nickel-rich pentlandite mineral (110) surface is mostly preferred amongst the three collectors. In addition, we observed that the Fe atoms had the strongest adsorption than Ni atoms. The calculated Bader charges showed that SEX and SIBX behaves as electron donor while the DEDTP as electron acceptor. This was also confirmed by the charge density difference, which showed charge accumulation on metals and charge depletion on S atoms of the collectors. Interestingly, we observed a charge accumulation at the internuclear region between the adsorbed metal and S atoms of collector. This indicated that some charges are localised in this region forming a normal covalent bond for DEDTP and back donation covalent bond for SEX and SIBX. The PDOS for the adsorbed system showed that the

<i>3p</i>-orbital HOMO peak is reduced near the EF, suggesting a strong interaction between the S of collectors and the Fe/Ni atoms.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Phuti E. Ngoeope
phuti.ngoepe@ul.ac.za
University of Limpopo

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Photonics / **205**

The Ultrafast Photo-Induced Metal-Insulator Phase Transition in Organic Cu(DCNQI)₂ Observed with Ultrafast Electron Diffraction

Author: Bart Smit[1]

Co-authors: Heinrich Schwoerer [1]; Nancy Payne [1]

[1] *Stellenbosch University*

Corresponding Author: absmit@sun.ac.za

The 1-dimensionally conductive organic material Cu(DNCQI)₂ has been a subject of interest due to its exotic macroscopic (conductivity) properties and the tuneability thereof. Depending on chemical composition, the crystal loses many orders of magnitude of conductivity within 1 K upon cooling. This phase transition is associated with a structural ('Peierls') transition of the (microscopic) lattice, where three crystal planes move together and form trimers. Despite the presence of a crystal lattice rearrangement, until now the only successful time resolved studies on Cu(DCNQI)₂ are on macroscopic properties of the material, such as ultrafast photoinduced conductivity measurements in bulk needles. We present the first study ever on this crystal (we used Me,Br-DCNQI, T_{transition} = 155 K) that reveals the microscopic molecular response on an ultrafast time scale, by using Ultrafast Electron Diffraction (UED).

The main findings of this study are the ultrafast (˜2ps) full suppression of the insulating trimer phase and a full recovery thereof within ˜40ps, which is one of the fastest macroscopic structural lattice phase transitions ever seen. We also observe an ultrafast change of the structure within the planes, linked to a distortion of the tetrahedral geometry of the crystal, with a slow (>ns) recovery. The successfully resolved molecular response (and the extracted ultrafast time constants) aid in understanding the underlying mechanisms of the photo-switched insulator-to-metal transition.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. Dr Heinrich Schwoerer
Stellenbosch University
heso@sun.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Physics of Condensed Matter and Materials 1 / 206

Simple approach to growth and characterization of ZnO/GO/P3HT layered nanostructures for solar cell devices

Author: Fokotsa Molefe[1]

Co-authors: Bakang Moses Mothudi [2]; MOHAMMED KHENFOUCH [3]; Mokhotjwa Simon Dhlamini [2]

[1] *Student at UNISA*

[2] *University of South Africa*

[3] *1 UNISA Africa Chair in Nanosciences-Nanotechnology, College of Science, Engineering and technology Science Campus, Corner of Christiaan de Wet Road & Pioneer Avenue, Florida, 1709, Johannesburg, South Africa. 2 University Sidi Mohamed Ben Abdellah, Faculty of Sciences Dhar el Mahraz, Laboratory of Solid state Physics, Group of Polymers and nanomaterials, BP 1796 Atlas Fez 30 000, Morocco.*

Corresponding Author: volksfmv@gmail.com

Poor performance of solar cell devices and low energy conversion brought great concern to researchers from different disciplines worldwide. As a result, various generations of solar cells have been implemented to tackle energy challenges. Within emerging generations of solar cells, layered devices are also gaining much interest due to charge transfer that takes place amongst the layers. In fact, for power conversion efficiency to be improved layered nanostructured materials need to be good electron donor and acceptor. Carbon containing nanomaterials offer the possibility of co-operative properties arising from interactions among the layered nanostructures. In the current study, simple and effective approach has been followed to prepare thin films of zinc oxide, graphene oxide (GO) and poly (3-hexylthiophene) (P3HT) in the form of layered structures for photovoltaic applications. Their structural, morphological and optical properties were investigated. The X-ray diffraction (XRD) studies revealed the interaction of layered structures through determination of the basal spacing and unit cell dimensions. As proof of concept of interaction, Field emission scanning electron microscopy (FE-SEM) images showed nanoflowers of ZnO and well defined graphene sheets upon growth of GO layer indicating that GO films were uniformly imbedded. FTIR confirmed the existence of C-O and C=C bonds. From UV/VIS/NIR we observed an enhanced absorption that validates the interaction with ZnO. Photoluminescence (PL) measurements showed quenching and shifting of emission spectra due to charge and energy transfer. Furthermore, an extensive study to probe effect of ZnO and GO on the optical constants of P3HT was conducted using Spectroscopic Ellipsometer (SE). Our work paves a way to fully understand interactions between ZnO/GO/P3HT layered structures using a simple and reproducible process for solar cell devices.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

B.M Mothudi, mothubm@unisa.ac.za, University of South Africa.

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 46 / **207**

Measurement of the visible cross sections for proton-proton collisions at 13 TeV with ALICE at the LHC

Author: sibaliso mhlanga[1]

[1] *ithemba LABS*

Corresponding Author: switsba@gmail.com

The performance of a particle collider is characterised by the luminosity, that is, the number of collisions produced over time per cross-section. At the LHC, luminosity determination is based on the cross-section of a reference process – the so called visible cross section measured in the van der Meer (VDM) scans.

The measurement of these cross sections is based on the particle detection in the ALICE luminometers , the TZERO (T0) and VZERO (V0) scintillators. These detectors cover both sides of the interaction point. The T0 covers the pseudo-rapidity $4.6 < \eta < 4.9$ (T0A), $-3.3 < \eta < -3.0$ (T0C) while the V0 detector covers the pseudo-rapidity $2.8 < \eta < 5.1$ (V0A), $-3.7 < \eta < -1.7$ (V0C). In this talk, we will present the measurement of visible cross sections performed with ALICE in the VDM scans during proton-proton collisions at $\sqrt{s} = 13$ TeV in 2015. Also, an outlook study of the measurements taken during VDM scans in 2016 will be given.

**Apply to be
 considered for a student
   award (Yes / No)?:**

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

PhD

**Main supervisor (name and email)
and his / her institution:**

Dr Zinhle Buthelezi
zinhle@tlabs.ac.za
iThemba LABS

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

no

Applied Physics / **208**

Detection of Cell Mismatch in Photovoltaic modules using Electroluminescence imaging

Author: Jacqui Crozier[1]

Co-authors: Ernest van Dyk [1]; Frederik Vorster [1]

[1] *NMMU*

Electroluminescence (EL) is a useful characterisation technique as it is fast, non-destructive and allows defects in photovoltaic (PV) cells and modules to be identified. The intensity of the emitted EL is proportional to the material, recombination and resistive properties of the cell. EL imaging is very

effective in detecting cell defects in modules such as cracks, broken fingers and broken cells. These defects have been shown to influence the power output of the modules proportional to the area affected. However, an EL classification scheme also needs to include the effects of cell mismatch due to Potential Induced Degradation (PID), Light Induced Degradation and poorly sorted cells. This cell mismatch is visible in the EL image as non-uniform EL intensity, where cells in the module appear darker or brighter than surrounding cells. This feature is not easy to visually identify and thus an image processing routine has been developed to identify non-uniform PV modules by mapping the variation in EL intensity.
In this study of a large number of EL images and the corresponding maximum power (PMAX) results have been used to assess the effects of cell mismatch on the performance of the module. This allows non-uniformity criteria to be developed that relates the non-uniform EL intensity of cells to the power output. Cell mismatch, visible as non-uniform intensity between cells is shown to be a contributing factor to power losses and an indication of module degradation.
This study produces a classification system that can be automatically assess EL images and can be applied to future research into the causes and effects of PID and other degradation in PV modules. This paper presents the classification criteria for cell mismatch and an analysis on the EL images in comparison with the measured power compared with the nominal power of the module.

Summary:

Electroluminescence (EL) is a useful characterisation technique as it is fast, non-destructive and allows defects in photovoltaic (PV) cells and modules to be identified. The intensity of the emitted EL is proportional to the material, recombination and resistive properties of the cell. EL imaging is very effective in detecting cell defects in modules such as cracks, broken fingers and broken cells. This study produces a classification system that can be automatically assess EL images and can be applied to future research into the causes and effects of PID and other degradation in PV modules. This paper presents the classification criteria for cell mismatch and an analysis on the EL images in comparison with the measured power compared with the nominal power of the module.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

EE van Dyk; ernest.vandyk@nmmu.ac.za; Nelson Mandela Metropolitan University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Physics of Condensed Matter and Materials 1 / 209

Computational and experimental study on effect of xanthate chain length on pyrite (FeS₂) mineral surfaces

Author: Peace Mkhonto[1]

Co-author: Belinda McFadzean [2]

[1] *University of Limpopo*

[2] *University of Cape Town*

In this study <i>ab-initio</i> computational and microcalorimetry methods were used to study the interaction of xanthate collectors of different chain lengths on pyrite (100) and (111) surfaces. The (100) surface was found to be more stable than the (111) surface as such more dominant during ore grinding. This is also confirmed by the surface morphologies of pyrite in both approaches. Four collectors were considered, (i.e. SEX, PNPX, PNBX and PAX). The HOMO and LUMO energies computed from DMol³ revealed that the PAX had the strongest ability to donate its electrons, while SEX had the strongest ability to accept electrons. Furthermore, PAX interaction on the surfaces is the most energetically favourable collector. We also observed that the (111) surface has the strongest heat of adsorption, which is attributed to less surface stability than the (100) surface. The calculated Mulliken atomic charges showed that the xanthate collectors behaves as electron donor with the Fe atoms accept charges, forming a back donation covalent bond. The microcalorimetry test showed similar trend as the DFT adsorptions, however the heats of adsorptions were lower than DFT values. The findings depict the behaviour of xanthate of different chain length and reveal that a longer hydrocarbon chain collector may increase the floatability of the pyrite mineral.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Phuti E. Ngoepe
phuti.ngoepe@ul.ac.za
University of Limpopo

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 29 / **210**

NUMERICAL SIMULATION OF STRUCTURAL, ELECTRONIC AND OPTICAL PROPERTIES OF VANADIUM DISELENIDE (VSe₂)

Author: Elkana Rugut[1]

Co-author: Daniel Joubert [1]

[1] *The National Institute for Theoretical Physics, School of Physics and Mandelstam Institute for Theoretical Physics, University of the Witwatersrand, Johannesburg, Wits 2050, South Africa*

Corresponding Author: elkanatawich@gmail.com

VSe₂ belongs to a group of compounds called transition metal dichalcogenides. This group of compounds have been exploited by several researchers both computationally and experimentally because of their intriguing properties such as low resistance, high chemical and mechanical stability, ease of synthesis among others that suites them for various applications ranging from catalysis, electronics, aerospace engineering to plasmonics just to mention a few which attracted our attention prompting us to investigate one of its members, that is VSe₂. In this regard, structural study of VSe₂ was undertaken using Perdew-Burke-Ernzerhof exchange correlation functional with two flavours of van der Walls correction namely Grimme (DFT-D2) and Tkatchenko-Scheffler (TS). This is because VSe₂ is layered material. From the structural data obtained PBE+DFT-D2 described the structural parameters of VSe₂ best. Vibrational properties via phonon calculations, mechanical properties via an elastic constant calculation and energetic properties via the calculation of formation and the cohesive energies confirm that VSe₂ is mechanically, dynamically and energetically stable in its trigonal phase. Furthermore, from carefully predicted electronic band structure and density of states, VSe₂ exhibits metallic character. Optical properties at the BSE level of approximation show that the compound is optically anisotropic with different absorption behaviour in-plane and out-of-plane. From the obtained values of the screened plasma frequency, VSe₂ is a promising plasmonic material.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Daniel Joubert, email address: Daniel.Joubert2@wits.ac.za , University of the Witwatersrand.

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Applied Physics / 211

Design and construction of a Digitally Controlled Function Generator

Author: Kreason Naidoo[1]

Co-authors: Francesco Petruccione [1]; Marco Mariola [2]

[1] *UKZN*

[2] *University of kwazulu-natal*

Corresponding Author: kreasonaaron@me.com

Many applications in Applied and Experimental Physics require the use of a function generator. These devices, while a staple of most labs, are expensive in nature and limiting in the way they operate. Most off-the-shelf, mid-range function generators will be able to provide a few different wave forms with the frequency and amplitude (voltage) of the wave being variable. The user would control these variables via the use of dials or buttons on the device itself. This analogue method to control the generator greatly limits how it can be used. Higher-end, digitally-controlled function generators are above the price point for many researchers or students

In this project we sought to create a low cost, digitally-controlled function generator. This custom-built generator would output a unipolar square wave that through the use of external filters could be converted into a range of periodic functions.

This custom function generator is built as a standalone device and as a module for the 'Africhino Quasi-Computer'. In future development, the function generator will be able to generate any function required by the user, including non-periodic functions.

Decreasing the cost of scientific endeavour, while maintaining quality, is the central tenant of the 'Africhino Quasi-Computer'. The function generator described above aims to be a part of a complete, low cost, laboratory instrument kit. Through this work we hope to bring advancements to the education, private and commercial sectors by reducing the associated costs and allowing the realisation of previously unattainable ideas.

To practically test the usability of the function generator, we decided to use it to drive Q-Plates in an optical scheme. These plates require specific frequencies and voltages on a bi-polar square wave to function correctly. This ordinarily would be a task suited to an off-the-shelf function generator, however by using our custom built function generator we were able to have a computer control the parameters of the wave, changing them as needed at a speed far faster than a human could in a manual, analogue operated system.

While this function generator is limited in the waves it can generate, it is a step forward towards a cheaper, more widely available scientific future.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof F Petruccione
petruccione@ukzn.ac.za

University of KwaZulu-Natal

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Applied Physics / **212**

Investigating the effects of Cobalt keV ion implantation on optical and magnetic properties of Indium Tin Oxide (ITO) thin films on flexible PET substrates

Author: Olakunle Oluwaleye[1]

Co-authors: Bonex Mwakikunga [2]; J. Sabata Moloi [1]; Mogan Madhuku [3]

[1] *University of South Africa*

[2] *CSIR, National Centre for Nano-Structured Materials, Pretoria, South Africa*

[3] *NRF-IThemba Labs (Gauteng), Johannesburg, South Africa*

Transparent conducting oxide (TCO) thin films exhibit co-existence of electronic conductivity and transparency. These unique properties enable TCOs to be applicable in optoelectronic and other nanodevices. Indium Tin Oxide (ITO) based TCO thin films have been used extensively in many applications, such as solar cells [1]. In particular, ITO has been a choice in flat panel displays as one of its electrodes. The major advantages of ITO are low resistivity, high transmission of visible light and high free carrier density that contributes to its relatively low electrical resistivity [2].
Modification of ITO thin films on polymer substrates using transition metal ion beams is rarely reported in literature. Therefore, to develop better dilute magnetic semiconductor (DMSs) for the improvement of spintronic devices, it is important to investigate dependence of optical and magnetic propertises of ITO thin films on Cobalt ion beam implantation.
In this work, studies of ion beam induced modification in ITO thin films used in optoelectronics will be presented. These films were deposited on flexible polyethylene terephthalate (PET) substrate. The ITO thin film samples were implanted with Co+ ions at different keV energies and fluences. Optical and magnetic properties of pristine and implanted samples, characterized by X-ray diffraction (XRD), UV-Visible Spectroscopy, Scanning Electron Microscopy (SEM) and Vibrating Sample Magnetometer (VSM), will be presented.

References
[1] Andreas Stadler. Transparent Conducting Oxides An Up-To-Date Overview.www.mdpi.com/journal/materials, 5:661–683, 2012.
[2] V. Gokulakrishnan et al. Effects of O7+ swift heavy ion irradiation on indium oxide thin films. Nucl. Instrum. and Methods, B269:1836–1840, 2011.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Name:S.J. Moloi
Email:moloisj@unisa.ac.za
Department of Physics
The Science Campus
Private Bag X 6
Florida, 1710
University of South Africa
Cnr. Christian de Wet Rd & Pioneer Avenue
Roodepoort, South Africa

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 56 / **213**

Building a ternary computer

Author: Nonky Ramohoeba[1]

Co-authors: Francesco Petruccione [2]; Marco Mariola [3]

[1] *University Of KwaZulu-Natal*

[2] *UKZN*

[3] *University of kwazulu-natal*

Calculations and automatic processes are generally performed by analogue, digital or hybrid computing depending on the problem to be solved. Nowadays the majority of calculations and control systems are executed on digital devices such as computers, microcontrollers and Field-Programmable Gate Arrays (FPGA). In the past other calculation machines such as analogue computer and ternary computer were proposed.
The development of analogue and ternary machines was abandoned in the past and in this research we aim to investigate the performance of the aforementioned systems, using modern electronic components. This research is particularly interested in ternary computers. The ternary machine does not use only two states but uses three level states. The ternary logic is also related with quantum computing and extreme machine learning [1].
Even though the research on ternary logic has been abandoned we intend to use its theoretical advantage of high memory and efficiency over binary codes. With the success in building the aforementioned circuits, experiments will be performed to compare digital, analogue, ternary and hybrid calculations performance. The device will be useful for better communication, computer simulations, military testing, encryption and automatic control systems.

References:

[1] Mark van Heeswijkn , Yoan Miche, "Binary/ternary extreme learning machines", Neuro Computing, Elsevier, December 2015.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Hons

**Main supervisor (name and email)
and his / her institution**:

Prof. F Petruccione.
petruccione@ukzn.ac.za

University of KwaZulu-Natal, School of Chemistry and Physics, Westville Campus, University Road 4000.

National Institute of Theoretical Physics, South Africa

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Space Science / **214**

Future spacecraft missions to the Sun

Author: Ruhann Steyn[1]

Co-author: Du Toit Strauss [2]

[1] *North-West University*

[2] *Centre for Space Research, North-West University*

Corresponding Author: ruhann@steyns.net

Solar energetic particles (SEPs) have aided our understanding of the structure of the Sun and the heliosphere between the Sun and the Earth on a more fundamental level. Historically, SEP events have been classified as either 'impulsive' or 'gradual' with solar flares and jets associated with the former and coronal mass ejections (CMEs) with the latter. Recently, this classification system has been challenged with an increasing number of in situ and remote sensing observations from several solar-orientated spacecraft. In this study, we investigate new scientific questions in light of the planned launch of the Solar Orbiter and Solar Probe spacecraft developed by the ESA and NASA, respectively.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Dr. R.D.T. Strauss
Dutoit.Strauss@nwu.ac.za
North-West University, Center for Space Research

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 65 / **215**

Analysis and Performance of a closed loop external cavity diode laser control system

Author: Victory Opeolu[1]

Co-authors: Adrian Wyngaard [1]; Gerhard De Jager [2]; Jordan Scarrot [1]; Kessie Govender [1]; Ouassini nemraoui [3]

[1] *Cape Peninsula University of Technology*

[2] *University of Cape Town*

[3] *Cape Peninsula university of Technology*

Corresponding Author: opeolu.victory@gmail.com

External cavity diode lasers (ECDL) are commonly used these days in laser cooling experiments involving Rubidium atoms. By adjusting the cavity length as well as the diode current the laser frequency can be finely tuned. The ECDL is locked to the appropriate Rubidium transition using a saturation absorption set together with a proportional-integral-derivative (PID) controller to control the cavity length and diode current. In this presentation we report on the analysis and performance of the closed loop control system using theoretical and numerically modelling, together with validation using experimental data.

**Apply to be
 considered for a student
   award (Yes / No)?:**

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

MEng

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Astrophysics / **216**

Structure formation with causal bulk viscosity

Author: Anslyn John[1]

Co-authors: Aurelie Penin [2]; Giovanni Acquaviva [3]

[1] *Rhodes University*

[2] *UKZN*

[3] *University of Zululand*

Corresponding Author: anslyn@gmail.com

The inclusion of dissipative effects in cosmic fluids modifies their clustering properties and could have observable effects on the formation of large-scale structures. We analyze the evolution of density perturbations of cold dark matter endowed with causal bulk viscosity. The perturbative analysis is carried out in the Newtonian approximation and the bulk viscosity is described by the causal Israel-Stewart (IS) theory. In contrast to the noncausal Eckart theory, we obtain a third-order evolution equation for the density contrast that depends on three free parameters. For certain parameter values, the density contrast and growth factor in IS mimic their behavior in ΛCDM when z≥1. Interestingly, and contrary to intuition, certain sets of parameters lead to an increase of the clustering.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

no

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Physics Education / **217**

An investigation of students' approaches in solving kinematic problems using linear equations of motion

Author: Sinovuyo Tanci[1]

Co-author: Mark Herbert [2]

[1] *University Western Cape*

[2] *University of the Western Cape*

Corresponding Author: sinovuyo.tanci@gmail.com

The presentation reports on a study investigating students' approaches in solving kinematic problems in the first year mainstream mechanics module, PHY111, in the Department of Physics at the University of the Western Cape. The module PHY111 focuses on explicit problem solving approach cognition and pedagogy. Pedagogy encourages students to actively participate through cooperative learning in class. It also engages students to model the problem and understand the physics concepts involved. The study investigated the type of problem solvers first year physics students are as well as the influence which the explicit problem solving approach of the PHY111 module had on their approaches in solving kinematic problems. This process was done by profiling students' problem solving approaches using pre-and post- surveys. An overview of the module PHY111 explicit problem approach in solving kinematic problems using linear equations of motion will be given in this presentation as well as the findings of the surveys.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Dr Mark Herbert
msherbert@uwc.ac.za
University of the Western Cape

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 57 / **218**

COMPUTATIONAL STUDY OF ELECTRONIC AND OPTICAL PROPERTIES OF THE CROCONATES DYE MOLECULES FOR APPLICATION IN DYE SENSITIZED SOLAR CELLS.

Author: Tshifhiwa Steve Ranwaha[1]

Co-authors: Ife Fortunate Elegbeleye [1]; Nnditshedzeni Eric Maluta [1]; Rapela Maphanga [2]

[1] *University of Venda*

[2] *University of Limpopo*

Corresponding Author: funawahau@gmail.com

Currently the dye sensitised solar cells have attracted more attention due to its low cost, transparency and flexibility. These types of solar cells uses the dye molecules adsorbed on the TiO₂ semiconductor in their architecture with the role of absorbing photon from the sun. The electronic structure and excitation properties of dye sensitizer determine the efficiency of the dye sensitised solar cell. The sensitizer absorbs the photon from the sun and then inject an electron on the TiO₂ semiconductor. In the current work the DFT calculations were employed to study the geometric, electronic and optical properties of two croconate dye molecules. The calculations are based on conjugate length, charge transfer distance and absorption bands. The analysis of the excited state properties and free energy changes for electron injection support that the croconates dye molecules can improve the efficiency of DSSCs as they can absorb on the near infrared, which increase the absorption range on the solar spectrum. The increase of absorption towards the infrared gives more probability of high photon absorption and electron transport on the large band gab TiO₂.

Keywords: Dye Sensitized Solar Cells, Dye, Croconate, Efficiency

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 30 / **219**

Electrical resistivity and the thermodynamic properties of the ferromagnet Nd2Pt2In

Author: Jean Jules Mboukam[1]

Co-authors: Amal Bashir [1]; Andre Strydom [2]; Buyisiwe Sondezi [2]; Dariusz Kaczorowski [3]; Moise Bertin Tchoula Tchokonte [4]; Ramesh Kumar [2]

[1] *University of the Western Cape*

[2] *University of Johannesburg*

[3] *Institute of Low Temperature and Structure Research, Polish Academy of Sciences, Wroclaw, Poland*

[4] *Department of Physics, University of the Western Cape*

Corresponding Author: mtchokonte@uwc.ac.za

The ferromagnet Nd2Pt2In compound was investigated by means of electrical resistivity, &rho(T), magnetic susceptibility, &chi(T), magnetization, M(μ0H), heat capacity, Cp(T) and magnetocaloric effect (MCE). Powder X − ray diffraction results confirm the tetragonal Mo2FeB2 − type crystal structure with space group P4/mbm (No. 127). At high temperatures, &rho(T) data shows metallic behaviour with a downward curvature and that is described by the Bloch − Gruneissen − Mott's relation. At low temperature, &rho(T) data shows an anomaly associated with ferromagnetism phase transition at TC = 18 K. Below TC, &rho(T) is well described by a spin − wave dispersion with energy

gap, &Delta = 15.7(9) K. &chi(T) data at high temperatures follows the Curie − Weiss relationship given and effective magnetic moment value, μeff = 3.61(2) μB and the Weiss temperature constant &thetap = 16(1) K. The observed μeff value is close to the value of 3.62 μB expected for the Nd3+ - ion. At low temperatures, &chi(T) data exhibit a sharp rise characteristic of ferromagnetic (FM) materials. TC was estimated at the minimum of d&chi(T)/dT curve at TC = 17.8 K, which is close to the value of 18 K observed in &rho(T) data. Cp(T) data confirms the FM phase transition at TC = 17.9 K taken at the midpoint of the maximum slope of the &lambda - type anomaly and close to the values of 18 K and 17.8 K observed in 7rho(T) and &chi(T) data respectively. The 4f − electron specific heat C4f(T), indicates a Schottky − type anomaly at high temperatures associated with crystalline − electric − field (CEF). The Arrott − plot indicate a second − order FM phase transition. The MCE estimated from the magnetization data gives value of 6.25 J/kg.K for a field change of 7T. The isothermal magnetic entropy change maximum (&Delta SMmax) follows a linear behaviour with h2/3 (h being the reduced field) with a negative y − intercept, which confirms the mean − field theory for a send − order phase transition.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof. Moise Tchoula Tchokonte, University of the Western Cape
mtchokonte@uwc.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 31 / **220**

Atomistic simulation of the structure and elastic properties of pentlandite

Author: Mofuti Mehlape[1]

Co-authors: Dakalo Tanzwani [2]; Phuti Ngoepe [2]

[1] *University Of Limpopo*

[2] *University of Limpopo*

Corresponding Author: mofuti.mehlape@ul.ac.za

Atomistic simulation was carried out to study the effect of pressure on the structure and elastic properties of pentlandite structures of the form M₉S₈ sulphides (M = metal). The lattice parameters, bond lengths and elastic constants as a function of pressure are calculated. 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 high pressures. We want to see how pressure changes the lattice parameters, elastic constants and bond lengths. We used computational techniques to investigate the effect of high pressure on the pentlandite structures. It was noted that as the pressure increases, the volume decreases. The elastic properties were found to be positive, which satisfies the conditions for a mechanically stable cubic structure.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 32 / **221**

Investigation of corrosion resistant nanocrystalline TiZrN layers deposited on ZIRLO

Author: Hlanganani Nyembe[1]

Co-authors: Arno Janse van Vuuren [1]; Jan Neethling [1]

[1] *Centre for HRTEM, Physics Department, Nelson Mandela Metropolitan University, Port Elizabeth*

Corresponding Author: nyembehs@gmail.com

Zirconium-based alloys (zircaloy and Zirlo) are used as nuclear fuel rod cladding in water-cooled nuclear reactors. Since zircaloy is oxidized by steam, which results in the release of hydrogen and the formation of brittle zirconium hydrides, the application of thin coatings on zircaloy to protect its surface from corrosion and reaction with hydrogen is currently enjoying considerable interest. Nanocrystalline TiZrN coatings have promising corrosion resistance characteristics and were therefore investigated as potential corrosion resistant coating on zirconium alloys. The nanocrystalline TiZrN coating was deposited onto a Zirlo substrate by cathodic arc physical vapor deposition (CA-PVD). A Helios NanoLab FIB was used to cut TEM lamellae from specific areas and these were investigated in a 200 kV JEOL 2100 TEM. The microstructural examination revealed that the coating exhibited a single TiZrN phase with columnar grains. The TiZrN nanocrystals are oriented with their close-packed {111} FCC planes parallel to the close-packed (001) planes of the HCP structure of the alpha phase of zirlo. Steam exposure of the TiZrN layers and Zirlo was performed in an autoclave and the results will be presented.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Jan Neethling
Jan.Neethling@nmmu.ac.za

Centre for HRTEM, Physics Department, Nelson Mandela Metropolitan University, Port Elizabeth

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Photonics / **222**

Single beam Supercontinuum Coherent Anti-stokes Raman Spectroscopy

Author: Ruan Viljoen[1]

Co-authors: Dirk-Mathys Spangenberg [2]; Erich Rohwer [2]; Hans-Martin Frey [3]; Pieter Neethling [4]

[1] *Stellenbosch University*

[2] *University of Stellenbosch*

[3] *Institute of Applied Physics, University of Bern*

[4] *Laser Research Institute, University of Stellenbosch*

Corresponding Author: 16107500@sun.ac.za

A number of different techniques utilizing a coherent supercontinuum from a photonic crystal fibre to produce a single-beam coherent anti-stokes Raman scattering (CARS) signals from a variety of samples have been demonstrated. In this presentation, we compare some of these techniques, employing amplitude, phase, and polarisation modulation techniques on our supercontinuum pulse to produce single beam CARS signals. The supercontinuum used in these measurements is produced in a polarisation maintaining all-normal dispersion photonic crystal fibre, which is characterised and compressed through an iterative pulse characterisation technique. We compare Raman spectra from BBO and Cyclohexane to literature values to test which of these methods produce the best signal to noise ratio.

**Apply to be
 considered for a student
   award (Yes / No)?:**

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

PhD

**Main supervisor (name and email)
and his / her institution:**

Prof Erich Rohwer
egr@sun.ac.za
Laser Research Institute

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

no

Nuclear, Particle and Radiation Physics 1 / 223

Measurements of gamma-ray production cross sections of proton beams at energies of 80-125 MeV with a natural calcium target.

Author: Ayanda Kunyana[1]

Co-authors: A BELHOUT [2]; A CHAFA [3]; B REBEIRO [4]; D MOUSSA [2]; Elena LAWRIE [5]; H BENHABILES [6]; I DELONCLE [7]; J KIENER [8]; J.j LAWRIE [5]; M DEDABI [2]; M.K RAJU [4]; N Kheswa [5]; P JONES [5]; S DAMACHE [9]; S OUICHAOUI [2]; Sifiso NTSHANGASE [10]; T.D BUCHER [5]; T.S DINOKO [5]; V RAMANATHAN [11]; W YAHIA-CHERIF [12]

[1] *University of Zululand*

[2] *Universite des Sciences et de la Technologie H.Boumediene*

[3] *Universite des Science et de la Technologie H.Boumediene*

[4] *University of Western Cape*

[5] *iThemba LABS*

[6] *Universite M'Hamed Bougara*

[7] *Centre ds Sciences Nucleaire et des Sciences de la Matiere*

[8] *Centre des Sciences Nucleaire et des Science de la Matiere*

[9] *Division de Physique*

[10] *UNIVERSITY OF ZULULAND*

[11] *University of Cape Town*

[12] *UniveUniversite des Sciences et de la Technologie H.Boumedienersite des Sciences et de la Technologie H.Boumediene*

Corresponding Author: cabeayanda@gmail.com

Gamma-ray production cross sections were measured for strong gamma-ray lines excited in the proton bombardment of a calcium target. The cross sections were obtained for the reaction natCa(p, pγ)40Ca, with a proton beam in the energy range from 80 MeV to 125 MeV delivered by the SSC cyclotron at iThemba LABS. The gamma-rays were detected with the high-purity Ge detectors of the AFRODITE array in the angular range from 90 to 168 degrees. We extracted excitation functions for these reactions for the first time. The results for the cross sections and their importance for astrophysics and medical therapy will be discussed.

**Apply to be
 considered for a student
   award (Yes / No)?**:

YES

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Dr E.A Lwarie
elena@tlabs.ac.za
iThemba LABS

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 66 / **224**

Infrastructure development for single beam Coherent Anti-Stokes Raman Spectroscopy

Author: Ruan Viljoen[1]

Co-authors: Dirk-Mathys Spangenberg [2]; Erich Rohwer [2]; Hans-Martin Frey [3]; Pieter Neethling [4]

[1] *Stellenbosch University*

[2] *University of Stellenbosch*

[3] *Institute of Applied Physics, University of Bern*

[4] *Laser Research Institute, University of Stellenbosch*

Corresponding Author: 16107500@sun.ac.za

Supercontinuum pulses produced by a polarisation maintaining all-normal dispersion photonic crystal fibre (ANDi-PCF) can be used to probe Raman active molecules and produce anti-Stokes Raman scattered light in a single beam setup. This supercontinuum is compressed and pumps and probes the sample 'simultaneously'. In this poster, we present the experimental setup used to perform such Raman measurements. The setup comprises the supercontinuum generation in the ANDi-PCF, the pulse compression and spectrum manipulation using a spatial light modulator in a 4f-shaper, as well as the microscope used to probe the sample. We compare and combine different methods

of probing the vibrational spectra of BBO and Cyclohexane by modulating the amplitude, phase and, polarisation of the supercontinuum pulses. The obtained spectra are compared with literature values.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof Erich Rohwer
egr@sun.ac.za
Laser Research Institute

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Physics of Condensed Matter and Materials 1 / 225

Properties of photoactive organic/inorganic hyrbrid thin films for solar cell applications

Author: Sfiso khanyile[1]

Co-author: Clive Oliphant [2]

[1] *University of Western Cape / NMISA*

[2] *NMISA*

Photoactive organic/inorganic hybrid thin films have been fabricated by spin coating a mixture of polymer/fullerene blended with silicon nanowires at different volume ratios. The main challenge faced by organic solar cells is poor stability leading to premature degradation of solar cell morphology and electronic properties which result in poor efficiencies. The incorporation of n type Si NWs into organic thin films enhances properties and improves stability of such films.
Surface morphology analysis of the hybrid thin films using optical microscopy and scanning electron microscopy exhibited a nonhomogeneous thin film with evenly distributed Si NWs which form random clusters. Structural information obtained from the grazing incidence XRD showed minimal peak shifting and an increase in lattice strain with varying Si NW ratios. Chemical analysis from X-ray photoelectron spectroscopy did not show the presence of Si due to sensitivity limitations. The UV-Vis absorption of the hybrid thin films was found to improve with the addition of Si NWs while the photoluminescence increased due to the porous and highly defective nature of the MACE Si NWs. Hall-effect measurements on the samples showed improved mobility and conductivity of the hybrid thin films.

Summary:

this work focuses on the fabrication of organic/inorganic hybrid thin films for solar cell applications. these films were synthesized by mixing P3HT/PCBM with Si NWs at different ratios and then spin coated on ITO substrates. these films were then characterized using a wide range of techniques in order to establish their properties.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Christopher Arendse
carendse@uwc.ac.za
University of Western Cape
Department of Physics and Astronomy

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 67 / **226**

Characterisation of sol-gel fabricated p-NiO/n-ZnO heterojunction

Author: Shadrach Akinkuade[1]

Co-authors: Bernard Mwakemwa [1]; Jacqueline Nel [1]; Walter Meyer [1]

[1] *UP*

Corresponding Author: u14302552@tuks.co.za

Zinc oxide nanorods were deposited on indium tin oxide (ITO) coated glass and silicon substrates, nickel oxide layer of 400 nm was deposited on the nanorods thereby forming a heterojunction between p-type nickel oxide and n-type zinc oxide thin films. The junction was characterised using x-ray diffraction (XRD), UV-visible spectroscopy, and scanning electron microscope. The current-voltage (I-V) characteristic of the junction was also investigated with and without ultra violet (UV) illumination.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Jacqueline Nel, jackie.nel@up.ac.za University of Pretoria

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Applied Physics / **227**

An Investigation of Synchronisation Techniques for a Handheld QKD Device

Author: Sharmini Pillay[1]

Co-authors: Francesco Petruccione [2]; Marco Mariola [2]

[1] *University of KwaZulu-Natal*

[2] *UKZN*

Corresponding Author: 206507614@stu.ukzn.ac.za

The importance of cryptography has become more prevalent in contemporary communication and the commercial use of Quantum Key Distribution (QKD) is now a realistic option for fibre networks. Long-range, free-space QKD and miniaturised, personal QKD devices are emerging fields of research aiming towards future commercial use. Previously, a handheld QKD device was developed using the COW protocol to exchange the encryption key between the sender and receiver [1]. An optical synchronisation system was developed for the handheld device establishing real time synchronisation between the sender and receiver.

This paper will investigate the viability of other synchronisation techniques appropriate for a handheld QKD device. The first technique will use asynchronous communication to establish communication between the sender and receiver. The second technique will use a radio channel to establish synchronisation, based on the methods designed in [2]. The tracking capabilities of the radio synchronisation method will assist a handheld QKD device in establishing a connection between devices that are not pre-aligned.

[1] Pillay, S., Mariola, M., Mirza, A. and Petruccione, F., Handheld QKD device using the COW protocol, in The Proceedings of the 60th Annual Conference of the South African Institute of Physics (SAIP2015)(ADDENDUM), edited by Makaiko Chithambo (RU) and André Venter (NMMU) (2015), pp. 29 - 35. ISBN: 978-0-620-70714-5.

[2] Mariola, M., Mirza, A. and Petruccione, F., Quantum cryptography for satellite communication, in Proceedings of SAIP2011, the 56th Annual Conference of the South African Institute of Physics, edited by I. Basson and A.E. Botha (University of South Africa, Pretoria, 2011), pp. 403 - 408. ISBN: 978-1-86888-688-3.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. Francesco Petruccione
petruccione@ukzn.ac.za
UKZN

Dr. Marco Mariola
Mariolam@ukzn.ac.za
UKZN

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Astrophysics / **228**

Discovery of a Shock Front in the merging cluster of galaxies ACO2163

Author: NCEBA MHLAHLO[1]

Co-authors: Loic Guennou [2]; Luigina Feretti [3]

[1] *WITS UNIVERSITY*

[2] *UKZN*

[3] *Istituto di Radioastronomia INAF*

Corresponding Author: nmgaxamba@gmail.com

ACO2163 is one of the hottest Abell galaxy clusters which has been observed countless times through different wavelengths and has always shown remarkable properties. We report a detection of a shock front in ACO2163 through the use of the X-ray and radio observations which were combined to determine the shock location in relation to the radio emission and other specific parameters inherent to the shock front. We used XMM-Newton observations and extracted spectra to determine the luminosity and temperature in the area around the edge of the cluster. From a temperature jump we obtain a Mach number of 2.2±0.3, which is a typical value for shocks in merging galaxy clusters.
The radio study has been conducted using the VLA data where we have done a spectral analysis of the halo region. We find that the south-western region of the cluster where the shock is located is globally flat, indicating the presence of energised electrons in this region.
To explain the electrons at the shock we invoke the Kang & Ryu model where shock acceleration occurs in a cloud of fossil relativistic electrons which can be provided by a radio galaxy.
Interestingly, we observe a radio galaxy in the region of the shock. If the shock is interacting with the electron cloud then the shock is currently re-accelerating the fossil relativistic electrons in the cloud, and will exit out of the cloud at cloud crossing time of ~54 Myr.
Another alternative explanation suggests a complex scenario in ACO2163 where a simultaneous compression and re-acceleration of pre-existing relativistic fossil electrons at the shock location could be taking place. We also consider simpler alternatives to explain the shock accelerated electrons.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Poster Session 2 - Board: 47 / **229**

Coupling of single neutron configuration to collective core excitations in ¹⁶²Yb using ¹⁶³Yb

Author: Makuhane Sithole[1]

Co-authors: John SHARPEY-SCHAFER [1]; Linda MDLETSHE [2]; Robert BARK [3]; SANDILE JONGILE [2]; Sifiso NTSHANGASE [4]; Siyabonga Majola [5]; Suzan BVUMBI [6]; Tshepo Dinoko [3]

[1] *University of the Western Cape*

[2] *University of Zululand*

[3] *iThemba LABS*

[4] *University of Cape Town / iThemba LABS*

[5] *iThemba Labs*

[6] *University of Johannesburg*

Corresponding Author: sitholemakuhaneabel@gmail.com

In odd-nuclei the single nucleon can couple to collective excitations of its even-even core nucleus. These collective excitations lie within the pairing gap and are therefore the lowest energy excitations of the core. Our physics motivation is to search for structures where an odd neutron couples to collective excitations of the ¹⁶²Yb core. We also intend to search for high-K structures

in this nucleus. The experiment ¹⁵²Sm(¹⁶O,5n)¹⁶³Yb at Elab = 93 MeV was performed to study ¹⁶³Yb at iThemba LABS. The gamma-decays from the reaction products have been detected using the AFRODITE gamma-ray spectrometer equipped with 8 escape-suppressed clover detectors. After a comprehensive analysis, the level scheme of ¹⁶³Yb has been extended and new bands have been established in this current work, in particular the band based on the ground state has been built up to spin 43/2- . A High-K band has been established in the current work for the first time in this nucleus. An additional 16 new states in ¹⁶³Yb were observed and all decay to the Yrast band. DCO and polarization analysis were performed to determine the spin and parity of new levels. The Cranked Shell Model was used for comparison of experimental data in this work.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof. J.F. Sharpey-Schafer
jfss@tlabs.ac.za
University of the Western Cape

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Nuclear, Particle and Radiation Physics 1 / 230

Measurements of natural radioactivity in sands using an array of lanthanum -bromide scintillator detectors

Author: M Bashir[1]

Co-authors: P Jones [2]; R. T Newman [3]

[1] *Stellenbosch University and Ibrahim Badamasi Babangida University*

[2] *iThemba Laboratory for Accelerator Based Sciences (iThemba LABS)*

[3] *Stellenbosch University*

Corresponding Author: bashirmunirat@yahoo.com

LaBr3:Ce detectors have been shown to be 1.2–1.65 times more efficient than NaI:Tl detectors above 350 keV, for 3.8 cm×3.8 cm (1.5 in.×1.5 in.) detectors and have an energy resolution of 2.5–3% at the 662 keV gamma-line of 137Cs, compared to 6–7% for NaI:Tl detectors[1]. The detector crystal has other advantages such as a high scintillation light output with a fast decay time[2]. An array of 8 2in x 2in LaBr3(Ce) scintillators with an XIA PIXIE-16 Digital Signal Processing system data acquisition system will be used to measure sands and KCl sample placed in the centre (24cm from each detector) of the array (with all detectors lying in the horizontal plane) for 12 hours. The gamma-gamma coincidence method has the advantage of virtually eliminating all background peaks that do not exist in coincidence with other peaks, significantly improving detection limits of useful radionuclides[3][4]. By employing a gamma-gamma coincidence condition, the background from the radioisotopes in the LaBr3:Ce scintillator is eliminated, providing a means for improving detection limits[5]. The absolute gamma–ray energy detection efficiency of each detector will be determined and compared. Data from each detector will be analyzed. The activity concentration of 238U, 232Th and 40K in the sands will be determined and compared to certified values. Time-stamped data will be collected and then coincidence conditions between detectors set offline. In this way this work can make a comparison between traditional single measurements and coincidence method.

Summary:

Reference
[1] K. Ciupek, S. Jednoróg, M. Fujak, and K. Szewczak, “Evaluation of efficiency for in situ gamma spectrometer based upon cerium-doped lanthanum bromide detector dedicated for environmental radiation monitoring,” J. Radioanal. Nucl. Chem., vol. 299, no. 3, pp. 1345–1350, 2014.
[2] A. Favalli, H. C. Mehner, and F. Simonelli, “Wide energy range efficiency calibration for a lanthanum bromide scintillation detector,” Radiat. Meas., vol. 43, no. 2–6, pp. 506–509, 2008.
[3] M. Yoho and S. Landsberger, “Determination of Selenium in coal fly ash via γ–γ coincidence neutron activation analysis,” J. Radioanal. Nucl. Chem., vol. 307, no. 1, pp. 733–737, Jan. 2016.
[4] S. Horne and S. Landsberger, “Selenium and mercury determination in biological samples using gamma–gamma coincidence and Compton suppression,” J. Radioanal. Nucl. Chem., vol. 291, no. 1, pp. 49–53, Jan. 2012.
[5] A. Drescher et al., “Gamma-gamma coincidence performance of LaBr3:Ce scintillation detectors vs HPGe detectors in high count-rate scenarios,” Appl. Radiat. Isot., vol. 122, no. January, pp. 116–120, 2017.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. R. T. Newman, rtnewman@sun.ac.za, Stellenbosch University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Theoretical and Computational Physics 1 / 231

Non-specialist lecture: Quantum measurement, but not as you know it

Author: Hermann Uys[1]

Co-authors: Pieter Du Toit [2]; Sibasish Gosh [3]; Thomas Konrad [4]

[1] *National Laser Centre, CSIR*

[2] *University of Pretoria / NMISA*

[3] *Institute of Mathematical Sciences, Chennai, India*

[4] *UKZN*

Corresponding Author: huys@csir.co.za

Standard courses in quantum mechanics focus teaching of quantum measurement on projective measurement of observables. Quantum theory, however, allows for a much broader class of measurements known as Positive Operator Valued Measures. Here we will discuss these generalized measurements, laying specific emphasis on so-called unsharp measurements. In particular, we will show that adding unsharp measurements to the toolbox of control protocols of quantum experimenters can allow useful applications like real-time state estimation and feedback control, noise protection of quantum systems, and measurement of dynamical correlation functions.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

n/a

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Astrophysics / 233

The effects of primordial chemistry and streaming velocities on Pop III star formation

Author: Matthew Unterslak[1]

Co-author: Andreas Faltenbacher [2]

[1] *Wits*

[2] *WITS*

Corresponding Author: matt.unterslak@gmail.com

It is widely accepted that during the cosmic evolution three stellar populations can be differentiated. The earliest stars, referred to as Pop III stars, form at redshifts (z) between 20 and 30. For those stars molecular hydrogen is dominant cooling agent within the proto-stellar clouds typically leading to giant stars with masses on the order of 100 Msun. These stars die quickly via supernovae events, polluting their local environment with metals, which speeds up gas cooling, leading to the formation of Pop II and Pop I stars. A second factor involved in the formation of the first stars is the effect of the decoupling of the photons and baryonic matter at z ~ 1020. This decoupling sets up a relative velocity between the dark matter and baryonic matter of ~ 30 km/s. Both processes have an impact on the formation time of the first stars, thereby altering the re-ionisation history of the Universe which will be observed by the SKA radio telescope. I will discuss the modeling of these two processes by state-of-the-art hydrodynamical simulations and the model predictions for future observations of the re-ionisation history of the Universe with the SKA.

Summary:

Discussion of the modeling of Pop III stars employing state-of-the-art hydrodynamical simulation techniques. Model predictions for future observations of the re-ionisation history of the Universe with the SKA.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Andreas Faltenbacher
faltenbacher@gmail.com
Wits

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Physics of Condensed Matter and Materials 1 / 234

Synthesis and Characterization of Spherical Gold and Silver Nanoparticles

Author: Phetola Selowa[1]

Co-authors: Akin Olaleru [1]; Joseph Kirui [1]

[1] *University of Venda*

Corresponding Author: akinolaleru@gmail.com

Syntheses of gold and silver nanoparticles have gained immense interest in the field of applied chemical research. This is because of the numerous and exciting physical and chemical properties of these nanomaterials. In this paper, gold nanoparticles (AuNPs) were prepared by citrate reduction method where by trisodium citrate acted as both reducing and capping agent, while silver nanoparticles (AgNPs) were prepared using sodium borohydride as a reducing agent, with trisodium citrate as a capping agent. The optical properties of the synthesized AuNPs and AgNPs were investigated by UV-Vis absorption spectroscopy where the surface plasmon resonance peaks were recorded at approximately 520 nm and 400 nm for AuNPs and AgNPs respectively. Transmission Electron Microscope (TEM) was employed in checking the morphology of the particles and size determination. For AuNPs the sizes were 14 nm, 20 nm and 40 nm for the samples PS01, PS02 and PS03, respectively, while for AgNPs they were 9.4 nm, 12.4 nm, 10.2 nm and 16.5nm for the samples PS06 ,PS07, PS08, and PS09, respectively. The surface charge of these nanoparticles was investigated by measuring the zeta potentials. The AuNPs were found to be negatively charged. Also, a study was performed to investigate the influence of reducing agents concentration on size of AuNPs and found that high concentrations of citrate led to smaller size of AuNPs. Application of silver nanoparticles (Ag NPs) in organic photovoltaic devices is of considerable interest. Surface plasmon resonance in Ag NPs offers great promise to enhance the power conversion efficiency (PCE) of organic solar cells as it exhibits strong local field enhancement around the Ag NPs. The nanoparticle can increase light scattering and absorption in the organic film.

Key words: Gold and Silver nanoparticles, Surface plasmon resonance (SPR), zeta potentials, organic photovoltaics (OPVs), power conversion efficiency (PCE).

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Dr JK.Kirui
Joseph.Kirui@univen.ac.za
University of Venda

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Photonics / **236**

Implementation of the orthonormal Zernike-based polynomials in the Extended Nijboer-Zernike diffraction theory

Author: Cosmas Mafusire[1]

Co-author: Tjaart Krüger [1]

[1] *University of Pretoria*

Corresponding Author: cosmasmafusire@gmail.com

The Nijboer-Zernike diffraction theory was devised to solve imaging problems in which the phase is represented as a linear combination of Zernike circle polynomials. The extension of the theory to create the Extended Zernike-Nijboer (ENZ) theory gives an allowance for the analysis of imaging systems with high numerical aperture and strong defocus. We investigate the implementation of circular Gaussian-Zernike-based polynomials in the ENZ theory in imaging systems with circular Gaussian pupils. The resulting semi-analytical model gives reasonably accurate results in the case of a diffraction-limited imaging system. The results show that the model allows for the simulation of weakly aberrated imaging systems, specifically phase and intensity profiles, axial intensity, point spread functions and analysis of the focal volume through comparison with numerical calculations. The model has potential use in simulating adaptive optics protocols in which the source of light is nonuniform, such as a laser. The model can also be used to characterize a laser source by decomposing its beam's point spread function to reveal the beam's aberration composition.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Tjaart P. J. Krüger
tjaart.kruger@up.ac.za
Department of Physics, Faculty of Natural and Agricultural Sciences, University of Pretoria,

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Photonics / **237**

Construction of a terahertz time-domain ellipsometer

Author: Shane Smith[1]

Co-authors: Erich Rohwer [2]; Pieter Neethling [3]

[1] *Physics Post Graduate Student*

[2] *University of Stellenbosch*

[3] *Laser Research Institute, University of Stellenbosch*

Terahertz time-domain spectroscopy is a powerful spectroscopic tool. Due to the long wavelength of terahertz radiation, it has a high penetration depth, thus allowing for high resolution at low intensity, and low photon energy, making it ideal for non-destructive spectroscopy. Normally terahertz spectroscopy is performed in transmission, due to the simplicity of such a setup and extracting information from the transmission data. Transmission setups have limitations unfortunately. Terahertz radiation is strongly absorbed by water and thus it is near impossible to analyse a sample in an aqueous environment, nor any other material that is optically dense to terahertz radiation. To investigate such samples, it would be preferable to work in reflection, but conventional reflection setups in terahertz spectroscope are very difficult to construct due to the accuracy required in the positioning of the reference sample relative the sample of interest in order to ensure the reliability of the measurement. To circumvent this problem, we constructed an ellipsometer with no need for a reference sample. In this talk we will be discussing the terahertz time-domain spectroscopic ellipsometer we have constructed, as well as measurements performed with this setup.

Summary:

In this talk we will be discussing the terahertz time-domain spectroscopic ellipsometer we have constructed, as well as measurements performed with this setup.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Pieter Neethling
pietern@sun.ac.za
Stellenbosch University - Physics Department
Laser Research Institute

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 68 / **238**

Introduction to ellipsometry with a focus on use with terahertz time-domain spectroscopy

Author: Shane Smith[1]

Co-authors: Erich Rohwer [2]; Pieter Neethling [1]

[1] *Laser Research Institute, University of Stellenbosch*

[2] *University of Stellenbosch*

Ellipsometry is a spectroscopic technique with which one can obtain both the refractive index and absorption coefficient of a sample by measuring the polarization resolved light reflected from it. This is especially useful in situations where making use of a reference sample is unwanted. Terahertz time-domain spectroscopy is a powerful spectroscopic tool, but terahertz radiation is strongly absorbed by water. Thus, it is near impossible to analyse a sample in an aqueous solution, or any other material that is optically dense to terahertz radiation, in transmission. To examine such samples, it would be preferable to work in reflection, but conventional reflection setups in the terahertz region are very difficult to construct due to the accuracy required in the positioning of a reference sample relative to the sample of interest. To circumvent this problem, we constructed a terahertz ellipsometer. On this poster, we will be discussing the basics of ellipsometry and its implementation in conjunction with terahertz time-domain spectroscopy.

Summary:

On this poster, we will be discussing the basics of ellipsometry and its implementation in conjunction with terahertz time-domain spectroscopy.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Pieter Neethling
pietern@sun.ac.za
Stellenbosch University - Physics Department
Laser Research institute

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 69 / **239**

Controlling the spatial distribution of multiplexed modes

Authors: Andrew Forbes[1]; Carmelo Rosales-Guzman[2]; NKOSIPHILE ANDILE BHEBHE[3]; Nyiku Mahonisi[4]; Shunmugam Ramsamy Naidoo[5]

[1] *CSIR*

[2] *University of the Witwatersrand, Johannesburg*

[3] *UNIVERSITY OF THE WITWATERSRAND*

[4] *University of Witwatersrand*

[5] *Wits University*

Corresponding Author: ncmahonisi@gmail.com

The computer-controlled shaping of light beams using digital holography has triggered the applications of these to a great variety of fields. Technological advances had provided with devices capable not only to generate almost any beam shape but also to multiplex multiple beams simultaneously. This property has provided a new tool to explore novel fields. The idea behind multiplexing is to encode each beam with a unique carrier frequency that in the Fourier plane translates into beams positioned at different locations. Hence, by controlling the carrier frequency of each beam it is possible to selectively send beams to specific locations. In this work we first study, via a correlation function of the experimentally generated beam against its theoretical counterpart, the maximum number of beams that can be multiplexed. We then show how this principle can be applied to generate multiple beams arrayed in well-defined symmetrical positions. Ultimately, this technique will allow us to selectively excite certain regions with fabricated Nitrogen vacancy (NV) centers on a diamond sample towards the generation of novel SPDC crystals of great relevance in the generation of single photons for secure communication channels.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof. Andrew Forbes, andrew.forbes@wits.ac.za, University of Witwatersrand & Prof. SR Naidoo, mervin.naidoo@wits.ac.za, University of Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Nuclear, Particle and Radiation Physics 2 / **240**

Search for boosted heavy neutrino with the ATLAS detector at the LHC

Author: Tshidiso Molupe[1]

Co-authors: Debarati Roy [1]; Deepak Kar [2]

[1] *University of the Witwatersrand*

[2] *University of Witwatersrand*

Corresponding Author: stmolupe@gmail.com

The search for the discovery potential at the LHC of a high-mass right handed (RH) gauge boson WR which decays to a heavy neutrino and a lepton. The neutrinos that are produced are highly boosted and subsequently decay via off-shell WR boson to jets and a lepton (N⟶ljj). The decay products are highly collimated, formi ng a single neutrino jet. The focus is on the regime where the WR is very heavy compared to the heavy Majorana neutrino N. In ATLAS, a large radius jet with an electron inside has never been looked at. The performance study will be shown

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Dr Deepak Kar deepak.kar@cern.ch University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Poster Session 2 - Board: 70 / **241**

Synthesis and characterization of Ce³⁺ doped NaMPO<sub>4</su (M= Mg, Ca, Sr and Ba) phosphors

Author: Prettier Morongoa Maleka[1]

[1] *Yes*

Corresponding Author: prettier.maleka@gmail.com

Cerium (Ce³⁺) doped alkaline-sodium-phosphate or NaMPO₄ (where M= Mg, Ca, Sr and Ba) phosphors were prepared by solution combustion method with different doping concentrations of Ce³⁺ (0.5 mol %, 1.0 mol % and 1.5 mol %). X-ray powder diffraction (XRD) and scanning electron microscope (SEM), were used to analyse the crystalline structure and particle morphology of the samples, respectively. The optical properties including reflectance, excitation and emission were investigated using UV-Vis absorption spectroscopy and photoluminescence (PL) spectroscopy while stretching modes and electronic and chemical composition were analyzed using Fourier transform infrared spectroscopy and X-ray photoelectron spectroscopy. The XRD and SEM results confirm that the samples contain mixture of phases of crystals. The excitation spectrum of the phosphors were characterized by broad band extending from 250 to 400 nm. The PL emission spectrum of the sample showed a broad band located between 310 and 400 nm in the UV range, which is due to the allowed 4f⁰5d¹ ⟶ 4f¹ 5d⁰transition of Ce³⁺ ions. The effects of Mg²⁺, Ca²⁺, Sr²⁺ and Ba²⁺ substitution on the particle morphology and photoluminescence emission intensity will be reported.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Ntwaeaborwa O.M ntwaeab@gmail.com University of the Witwatersrand
Swart HC swarthc@ufs.ac.za university of Free state
Reddy K krishr@uj.ac.za university of Johannesburg
Avula B balakrishna.veera@gmail.com university of free state

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Nuclear, Particle and Radiation Physics 1 / **242**

The (d,3He) single-nucleon transfer reaction

Authors: Philip Adsley[1]; Retief Neveling[2]

[1] *University of Stellenbosch/iThemba LABS*

[2] *iThemba LABS*

Corresponding Author: neveling@tlabs.ac.za

The use of single-nucleon transfer reactions can be used to probe nucleon occupancies and vacancies. In heavier nuclei, the presence of high-spin orbitals (e.g. the g9/2 and h11/2 orbitals) makes these transfer reactions more difficult to carry out. One particular problem relates to the energy requirement for the incident particle used to populate highly excited contributions from these orbitals. The relatively high energy of beams required are not available from tandem accelerators and necessitate the use of a cyclotron. Only two cyclotron facilities worldwide have available the combination of beam energies and magnetic spectrometers for these experiments to be carried out (Grand Raiden at RCNP, Osaka and the K600 at iThemba). The focus of such studies are transfer reactions along isotopic or isotonic chains to test the evolution of the shell model in these cases. The merits of studying the 69Cu nucleus at iThemba LABS will be discussed.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Photonics / **243**

Controlling light harvesting with light

Author: Tjaart Krüger[1]

Co-authors: Diana Kirilovsky [2]; Michal Gwizdala [3]; Rienk van Grondelle [4]; Rudi Berera [5]

[1] *University of Pretoria*

[2] *CEA-Saclay*

[3] *UP*

[4] *VU University Amsterdam*

[5] *Kagawa University*

Corresponding Author: tjaart.kruger@up.ac.za

When exposed to intense sunlight all organisms performing oxygenic photosynthesis implement various photoprotective strategies to prevent potentially lethal photodamage. The rapidly responding photoprotective mechanisms, occurring in the light-harvesting pigment-protein antennae, take effect within tens of seconds, while the dramatic and potentially harmful light intensity fluctuations manifest also on shorter timescales. Here we show that upon illumination, individual phycobilisomes from Synechocystis PCC 6803, which in vivo under low-light conditions harvest solar energy, have the inbuilt capacity to switch rapidly and reversibly into light-activated energy-dissipating states. Simultaneously measured fluorescence intensity, lifetime and spectra, compared with a multi-compartmental kinetic model, revealed that essentially any subunit of a phycobilisome can be quenched, and that the core complexes were targeted most frequently. Our results provide the first evidence for fluorescence blinking from a biologically active system at physiological light intensities and suggest that the light-controlled switches to intrinsically available energy dissipating states are responsible for a novel type of photoprotection in cyanobacteria. We anticipate other photosynthetic organisms to employ similar strategies to respond instantly to rapid solar light intensity fluctuations. A detailed understanding of the photophysics of photosynthetic antenna complexes is of great interest for bioinspired solar energy technologies.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Nuclear, Particle and Radiation Physics 1 / 244

Non-radiating accelerating electrons

Author: Jason Webster[1]

Co-authors: Andrew Forbes [2]; Benjamin McMorran [3]; Jordan Pierce [3]; Melanie McLaren [4]

[1] *University of Stellenbosch*

[2] *CSIR*

[3] *University of Oregon*

[4] *University of Witwatersrand*

Corresponding Author: jasonrobwebster@gmail.com

Charged particles following curved paths are known to produce synchrotron radiation. This radiation causes a power loss that serves as a limiting factor when producing high energy particle collisions, particularly when the radius of curvature is small or the speed is close to <i>c</i>. Typically, one makes use of the electron in such high energy experiments and treats this as a classical particle. Here, we've made use of the wave nature of electrons in order to produce a structured electron wave field, and have demonstrated the creation of an angularly accelerating beam of electrons that produces no radiation. Additionally, we have made theoretical predictions on the electromagnetic field surrounding such a beam to understand why such a beam does not radiate.

Summary:

By structuring the wave nature of charged particles, we've demonstrated the creation of an angularly accelerating electron Bessel beam that produces no radiation, which goes against the classical notion that a charged particle must radiate upon acceleration. Additionally, we make theoretical predictions on the electromagnetic field surrounding such a beam.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Hons

**Main supervisor (name and email)
and his / her institution**:

Andrew Forbes
University of the Witwatersrand
andrew.forbes@wits.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Nuclear, Particle and Radiation Physics 2 / 245

J/ψ suppression at forward rapidity in Pb–Pb collisions

Author: Siegfried Förtsch[1]

[1] *iThemba LABS*

Corresponding Author: fortsch@tlabs.ac.za

The Quark Gluon Plasma (QGP), characterized by high temperature and density, is a state of strongly interacting matter in which the constituents of hadronic matter, the quarks and gluons, are no longer confined. Some of the most sensitive probes of the QGP are charmonia and bottomonia, which are bound states of charm–anticharm (c-$\bar{c}$) or bottom–antibottom (b-$\bar{b}$) quarks, respectively. Early theoretical models predicted a suppression of these bound states to be induced by the screening of the color force in a deconfined medium and to become stronger as the QGP temperature increases. For the J/Ψ meson, the ground $c\bar{c}$ state, a suppression was found for nucleus-nucleus interactions at centre-of-mass energy per nucleon pair, √sNN, ranging from 17.62 GeV to 2.76 TeV. However, at 2.76 TeV this suppression is found to be lower than observed at lower energies. This observation is unexpected since the initial temperature of the QGP is higher at 2.76 TeV. This could be explained in terms of contributions from J/ψ regeneration via a recombination mechanism between the c and $\bar{c}$ quarks during the phase of no confinement and/or the hadronisation phase of the medium. This interplay between suppression and regeneration of J/ψ production at the LHC can be studied further by comparing the centrality and pT dependence of the J/ψ, measured at √sNN=2.76 TeV, to that obtained at √sNN=5.02 TeV, the highest energy available in nuclear collisions.
Recently the ALICE Collaboration presented the first results on the J/ψ measured in Pb–Pb collisions at √sNN=5.02 TeV and the integrated and pT-differential J/ψ production cross section in pp collisions at the same energy. In both Pb–Pb and pp collisions, the J/ψ is reconstructed via its dimuon decay

channel at forward rapidity, 2.5<y<4 and for pT<12 GeV/c. This presentation will focus on the comparison of these data with the earlier measurements at $\sqrt{s_{NN}}$=2.76 TeV, together with theoretical calculations which could provide insights in the evolution of the relative contribution of the two processes.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

None

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Physics of Condensed Matter and Materials 1 / 246

Nano-fabricated SiN holograms for probing matter with structured waves

Author: Jason Webster[1]

Co-authors: Andrew Forbes [2]; Benjamin McMorran [3]; Jordan Pierce [3]; Melanie McLaren [4]

[1] *University of Stellenbosch*

[2] *CSIR*

[3] *University of Oregon*

[4] *University of Witwatersrand*

Corresponding Author: jasonrobwebster@gmail.com

Structuring matter is typically associated with structuring the particle nature of matter in its physical form. At the micro and nano scales, such matter manipulation is typically achieved through the use of a focused ion beam (FIB) instrument, allowing for applications within transmission electron microscopy (TEM), micromachining, semiconductor ion implantation, and many others. Here, we demonstrate the creation of a FIB manufactured SiN diffraction grating for use in a TEM, allowing us to structure the wave nature of electrons, where as an example we demonstrate the creation of an angularly accelerating electron Bessel beam. These SiN gratings can act as holograms for matter waves, and have already opened up prospects for probing deeper into complex material properties than is currently possible with standard TEM techniques.

Summary:

We've shown the development of a hologram for matter waves and have used a particular hologram to structure an angularly accelerating electron beam within a TEM. The procedure for generating the hologram as well as the necessary materials required are highlighted, along with the procedure required in order to control the resulting beam shape.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Hons

**Main supervisor (name and email)
and his / her institution**:

Andrew Forbes
University of the Witwatersrand

andrew.forbes@wits.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Physics of Condensed Matter and Materials 1 / 247

Characterisation of the optical properties of silver nanoparticles (Ag NPs) for enhancing organic photovoltaic (OPV) device performance.

Author: Kenneth Baloyi[1]

Co-authors: Joseph Kirui [1]; Lordwell Jhamba [1]

[1] *University of Venda*

The main aim of the study was to enhance the overall performance of the photovoltaic device through incorporation of silver nanoparticles (Ag NPs). Eight glass plates coated with indium tin oxide (ITO) on one side were used; two of them were etched by reacting hydrochloric acid with zinc powder. Silver nanoparticles of varying concentrations were then deposited on the ITO-glass substrates using radio frequency (RF) sputtering method. Poly(3,4-ethyleredioxythiopene) polystyrene sulfonate (PEDOT:PSS) was deposited onto the etched substrates using spin coating method. The optical properties were investigated using UV-Visible absorption spectroscopy where the surface plasmon peaks were recorded approximately 347 nm and 576 nm for transmittance and absorption respectively. The effect of both low and high concentrations of Ag NPs were studied; the former allowed more light to pass through whereas the latter caused the shifting of peaks to the visible region. In addition, PEDOT:PSS reduces the reflective properties of glass and generate a negative absorbance and hence more electron-hole pairs.

Key Words: surface plasmon resonance (SPR), radio frequency (RF) sputtering, Ag NPs, PEDOT:PSS, ITO

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Dr JK Kirui,
University of Venda

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Space Science / 248

Overtaking collisions of small-amplitude supersolitons in a plasma with cold ions and two-temperature Boltzmann electrons

Author: Carel Olivier[1]

Co-author: Frank Verheest [2]

[1] *North-West University*

[2] *University of Ghent*

Corresponding Author: carel.olivier@nwu.ac.za

Solitons are spatially localized solitary waves that propagate without changing shape or velocity, and arise as bipolar structures in the electric field. A special class of solitons have recently been reported, namely supersolitons [1]. Supersolitons are deformed solitons with additional local minima and maxima in the electric field, giving rise to so-called "wiggles in the tails". Supersolitons have been predicted theoretically in many different plasma models. It was also shown to be stable via fluid simulations [2]. However, the collision properties have not been considered. In this paper, we use a reductive perturbation analysis to study supersolitons in a plasma consisting of cold ions and two-temperature Boltzmann electrons. A Korteweg-deVries-type equation is derived that governs small-amplitude supersolitons. This equation is used to simulate supersoliton collisions, in order to determine the properties of overtaking soliton-supersoliton and supersoliton-supersoliton collisions.

[1] A. E. Dubinov and D. Yu. Kolotkov, Interpretation of ion-acoustic solitons of unusual form in experiments in SF_6-Ar plasma, High Energy Chem. 46, 349—353 (2012).

[2] A. Kakad, A. Lotekar and B. Kakad, First-ever model simulation of the new subclass of solitons "Supersolitons" in plasma, Phys. Plasmas 23, 110702 (2016)

Summary:

We use a reductive perturbation analysis to study supersolitons in a plasma consisting of cold ions and two-temperature Boltzmann electrons. A Korteweg-deVries-type equation is derived that governs small-amplitude supersolitons. This equation is used to simulate supersoliton collisions, in order to determine the properties of overtaking soliton-supersoliton and supersoliton-supersoliton collisions.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Dr. Du Toit Strauss
North-West University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Physics of Condensed Matter and Materials 1 / 249

Thermoelectric properties of CH₃NH₃PbI<sub>3</s using density functional theory and Boltzmann transport calculations

Author: Ibrahim Abdallah[1]

Co-authors: Daniel Joubert [2]; Mohammed Suleiman [3]

[1] *chool of Physics, University of the Witwatersrand*

[2] *School of Physics, University of the Witwatersrand*

[3] *Department of Basic Sciences, Imam Abdulrahman Bin Faisal University, Dammam, KSA.*

Corresponding Author: ibraphysics@gmail.com

The thermoelectric properties of organic-inorganic halide perovskite CH₃NH₃PbI₃ were studied by solving the semiclassical Boltzmann transport equations on top of density functional theory calculations by using maximally-localised Wannier functions (MLWFs). Electronic transport properties were evaluated within the constant relaxation time approximation at four different temperatures 300 K, 500 K, 700 K, and 900 K. The electrical conductivity (σ) was found to be almost constant in the entire temperature range, while the Seebeck coefficient (S) was found to decrease with increasing temperature and the electronic thermal conductivity (κ) was found to increase with increasing temperature. Theoretical results for the power factor (S^{<i>2</i>} σ) and the figure of merit (ZT) are analysed. The highest predicted average figure of merit is 0.85 at 900 K.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Daniel P. Joubert
Daniel.Joubert2@wits.ac.za
The National Institute for Theoretical Physics, School of Physics and Mandelstam Institute for Theoretical Physics,
University of the Witwatersrand, Johannesburg, Wits 2050, South Africa.

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Poster Session 1 - Board: 33 / **250**

Kondo and crystal - eletcric field effects andMagnetic behaviour in Ce8Pd24(Al1−xSnx)

Author: Aiman Bashir[1]

Co-authors: Andre Strydom [2]; Moise Tchokonte [3]

[1] *University of the western Cape*

[2] *university of Johanseburge*

[3] *university of the western cape*

Corresponding Author: abashir@uwc.ac.za

The compounds Ce8Pd24(Al1−xSnx), (0 < x <1) have been studied by means of electrical resistivity, &Rho(T), thermoelectric power,
S(T), thermal conductivity, &lambda(T), magnetic susceptibility, &Chi(T) and magnetization, M(&mu0H) measurements. All investigated
compositions crystallize in a cubic AuCu3 - type crystal structure with space group Pm3m (No. 221). &Rho(T) data is dominated by
both coherent Kondo lattice scattering and crystal-electric field effect (CEF) for alloys in the concentration range 0 < x < 0.7
and by only CEF effect for alloys with x< 0.8. At low temperature &Chi(T) data indicate a steep decrease at TN associated with

antiferromagnetic (AFM) phase transition for all compositions. Below TN, &Chi(T) is described by a spin - wave dispersion relation with
an energy gap &delta. The high temperature S(T) data is described by the phenomenological resonance model giving the characteristic
temperature TCEF associated with CEF effect. &lambda(T)(T) increase linearly with temperatures from low T. The reduced Lorentz number,
L/L0 increase upon cooling and exhibit maxima which decrease in magnitude with increasing x. &Chi(T) data at high temperature
for all compositions follows the paramagnetic Curie - Weiss relation with negative Weiss temperatures constant &theta p and effective
magnetic moments μeff close to the value of 2.54 μB expected for the free Ce3+ - ion. The low temperature dc &Chi(T)(T) data indicate
an AFM anomaly for all compositions, associated with a N´eel temperature ranging from TN = 4.3 K to 7 K between the two
end compounds also observed in the $Rho(T) results. Field - cooling (FC) and zero - field - cooling (ZFC) &Chi(T)(T) data indicates spin -
glass behaviour at Al concentrated alloys. M(&mu0H) data increase linearly with field up to 5 T, with no evidence of metamagnetic
transition and hysteresis loop.

**Apply to be
 considered for a student
   award (Yes / No)?:**

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

PhD

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Poster Session 2 - Board: 71 / **251**

Microstructural, Photoluminescence and Raman properties of highly Cu doped ZnO nanorods.

Author: Benard Mwankemwa[1]

Co-authors: Jackie Nel [1]; Mmantsae Diale [1]; Shadrach Akinkuade [1]

[1] *UP*

Corresponding Author: benard_80@yahoo.com

In this study, we report on the chemical bath deposited (CBD) copper (Cu) doped ZnO nanorods. X-ray diffraction (XRD), scanning electron microscope (SEM), Raman and photoluminescence (PL) studies have been done in order to investigate the effect of doping concentration on ZnO nanostructures. XRD patterns of the ZnO nanorods, show a remarkably strong diffraction peak along the (002) direction indicating the formation of hexagonal wurtzite structure of ZnO. The intensity of longitudinal optical peak, E1 (LO) observed in the Raman spectra ZnO nanostructures increased with increase in doping concentrations, confirming the formation of defect with doping. Photoluminescence spectra of Cu doped ZnO nanorods shows ultraviolet (UV) emission along with visible emission peaks while undoped ZnO showed only UV emission peak.

**Apply to be
 considered for a student
   award (Yes / No)?:**

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

PhD

**Main supervisor (name and email)
and his / her institution**:

Mmantsae Diale
Mmantsae.Diale@up.ac.za
UP

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Nuclear, Particle and Radiation Physics 2 / 252

Heavy-quark production vs multiplicity in small systems at LHC energies

Author: Zinhle Buthelezi[1]

[1] *iThemba LABS*

Corresponding Author: zinhle@tlabs.ac.za

Heavy quarks are produced in hard parton scatterings in the initial stages of hadronic collisions and are important tools for studying various aspects of QCD. Heavy-quark measurements as a function of multiplicity give insight into processes influencing their production in hadronic collisions at LHC energies. Also, they provide a way to test the possible influence of multi-parton interactions. Furthermore, the dependence of heavy-quark production on multiplicity is used to test QCD theoretical models.

The ALICE Collaboration has measured the production of heavy-flavour hadrons as a function of multiplicity in pp collisions at $\sqrt{s}$ = 7 TeV and in p-Pb collisions at $\sqrt{s}$_NN = 5.02 TeV. The measurements of heavy-quark production are performed via the hadronic and semi-leptonic decay channels at mid-rapidity and the multiplicity is measured at central and forward rapidity. The presentation will focus on the results obtained from these measurements and compare them to theoretical model calculations, where applicable

**Apply to be
 considered for a student
   award (Yes / No)?**:

NO

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/Z

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

NO

Theoretical and Computational Physics 1 / 253

Non-reversal Open Quantum Walks

Author: Hazmatally Goolam Hossen[1]

Co-authors: Francesco Petruccione [1]; Ilya Sinayskiy [1]

[1] *UKZN*

Corresponding Author: hazmatally@gmail.com

A model of non-reversal quantum walk is introduced. In such a walk, the walker cannot go back to previously visited sites but it can stay on the same site or move to a new site. The process is introduced on a line using the formalism of Open Quantum Walks (OQWs). Afterwards, the non-reversal OQW is demonstrated in <i>2D</i>. The "quantum coin" used consists of Kraus operators, each representing one direction. Examples of some trajectories and distributions are given. An interesting relationship is formulated between the radius of the spread and the number of steps of the walk. The results are compared with the ordinary OQW and the classical Self-Avoiding Walk.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Supervisor: Professor Francesco Petruccione
Petruccione@ukzn.ac.za

Co-supervisor: Doctor Ilya Sinayskiy
Sinayskiy@ukzn.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 58 / **254**

Micro-indentation Hardness Increase in Ion Implanted Boron Nitride

Author: Lehlohonolo Lisema[1]

Co-authors: Emily Aradi [2]; Morgan Madhuku [3]; Ronald Machaka [4]; Thabang Magabe [1]; Trevor Derry [5]

[1] *Wits*

[2] *University of Huddersfield*

[3] *iThemba LABS*

[4] *CSIR*

[5] *University of the Witwatersrand*

Corresponding Author: trevor.derry@wits.ac.za

Previously we have shown that implantation of the hexagonal allotrope of boron nitride with light ions (e.g. He+, Li+, B+) produces a surface layer containing nanoparticles of the much harder cubic allotrope, as revealed by Raman spectroscopy, X-ray diffraction and electron microscopy. We now show that the irradiated layer is measurably harder when interrogated by micro-indentation which probes a layer comparable to the ion range. The hardness value increases reproducibly with the ion fluence, confirming that the latter is responsible for it. There are possible implications for the surface hardening of BN components after they have been configured in the easily machinable hexagonal form. Some aspects of the hardening mechanism are discussed.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof. T.E. Derry, Trevor.Derry@wits.ac.za
University of the Witwatersrand

Co-supervisor Dr. Morgan Madhuku, Madhuku@tlabs.ac.za
iThemba LABS (Gauteng)

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 59 / **255**

Feasibility study of acquiring a photovoltaic system at Tshwane University of Technology, Arcadia Campus

Author: Nicolas Thantsha[1]

Co-author: Kittessa Roro [2]

[1] *Tshwane University of Technology*

[2] *Energy Centre, CSIR*

Corresponding Author: thantshanm@tut.ac.za

Power system across the world is in transition from centralized to distributed systems. In South Africa, the life time cost of residential and commercial Photovoltaic (PV) systems is less than the country's grid power today. In this study, therefore, the feasibility of acquiring a PV asset at Tshwane University of Technology (TUT) Arcadia campus was conducted. For this, the assessment of the energy consumption of a building as well as the solar potential was done by using PVsyst commercial software. The anticipated energy generation, return on investment, and benefits of using solar energy was determined. A summary of the impact of integrating PV system into campus grid will be presented. The spin-off of this exercise will be the stimulation of the PV research and development at the institution. It is anticipated that the facility will be used for future training of students to assist the growing PV industry in South Africa.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 48 / **256**

Coupling of single neutron and proton configurations to collective core excitations in ¹⁶²Yb.

Author: Linda Mdletshe[1]

Co-authors: A. M Sithole [2]; J. F Sharpey-Schafer [2]; N. A Khumalo [2]; R. A Bark [3]; S Jongile [1]; S. N. T Majola [3]; S. S Ntshangase [1]; T. S Dinoko [3]

[1] *University of Zululand*

[2] *University of the Western Cape*

[3] *iThemba LABS*

Corresponding Author: linda.mdletshe@gmail.com

The excited states of ¹⁶²Yb have been studied at iThemba Laboratory for Accelerator Based Sciences (iThemba LABS), using the ¹⁵⁰Sm (¹⁶O, 4n)¹⁶²Yb fusion-evaporation reaction. The beam of 83 MeV ¹⁶O was provided by the Separated-Sector Cyclotron (SSC) and used to bombard a 3 m/cm² ¹⁵⁰Sm target. The &gamma -rays emitted from the reaction products were detected using the AFRODITE &gamma -ray spectrometer, comprised of 8 Compton-suppressed clover detectors. Attempts have been made to identify the low-lying excited states in ¹⁶²Yb. Many levels have been found. In particular the first excited 0₂⁺ band and the even and odd sequences of the &gamma band have been firmly established. The 0₂⁺ band and the even spin members of the &gamma band are observed to exhibit a Laundau-Zenner crossing. This crossing demonstrates that the signature splitting in &gamma bands is mainly caused by band mixing. The data will be discussed in terms of the Triaxial Projected Shell Model and also with the predictions of the 5-Dimensional Collective Model (5-DCM).

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Dr. S. S. Ntshangase
ntshangases@unizulu.ac.za
University of Zululand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 49 / **257**

Chilarity in 193Tl

Author: Joram Ndayishimye[1]

Co-author: Elena Lawrie [1]

[1] *iThemba LABS*

Corresponding Author: joram@tlabs.ac.za

Research conducted at iThemba LABS showed that chiral symmetry can develop in the thallium isotopes in the 190 mass region. In order to increase the knowledge about chirality in this mass region, a ɣ-spectroscopy study of 193Tl was performed at iThemba LABS. The previous level scheme of 193Tl was modified and extended. Spin and parity were assigned to most of the levels. Three negative parity bands
showing similar properties were identified. These bands were associated with the same configuration which is suitable for chiral symmetry. The observed near-degeneracy is good and indicates the presence of chiral symmetry. Furthermore, two bands that could form a chiral pair were observed at

higher spins. The results from theoretical calculations using the Cranked Nilsson-Strutinsky (CNS) codes and the multi-particle-plus-triaxial rotor (MPR) model of Carlsson and Ragnarsson are in agreement with the proposed observation of chiral symmetry. Possible multiplet of chiral systems will be discussed.

Summary:

A study to search for chirality in 193Tl was conducted at iThemba LABS. Similarity of properties that was observed in in a number of bands suggests that multipple chiral systems could be present in 193Tl. Theoretical calculations that were performed are in good agreement with the presence of chiral symmetry in 193Tl.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Supervisor: Dr. E. A. Lawrie
Email: elena@tlabs.ac.za
Institution: iThemba LABS

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Theoretical and Computational Physics 1 / 258

Evaluation of Garcia Regression Constants using Meteorological Data in Pretoria Arcadia, South Africa.

Author: Sophie Mulaudzi[1]

Co-author: Nnditshedzeni Eric Maluta [1]

[1] *University of Venda*

Corresponding Author: sophie.mulaudzi@univen.ac.za

The success of the harnessing of solar energy at its best depends on the availability of accurate global solar radiation data. Due to high costs of the meteorological measuring equipment and lack of technical skills for calibrating these instruments in many developing countries like South Africa, an alternative method has to be employed. The use of the developed solar models to estimate the global solar radiation data becomes vital in this regard. In this study, the Garcia regression constants α “and “ β from the relation, $G/G_0 = \alpha + \beta * \Delta T/N_p$, of Pretoria Arcadia station at Western Cape were evaluated. The model uses the possible sunshine hours, N_p and the air temperature, T at the study area. Two years' meteorological data was used to determine the regression constants. The estimated global solar radiation data was then computed for the period of ten years and compared with the in-situ data. For the validation of the model, statistical analysis was also performed and reflected good relationship between the estimated and the measured global solar radiation data.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 41 / **259**

Comparison of ionospheric scintillation proxies derived from high sampling rate GNSS data.

Author: Pierre Cilliers[1]

Co-author: joseph olwendo [2]

[1] *SANSA Space Science*

[2] *Pwani University*

Corresponding Author: pjcilliers@sansa.org.za

Ionospheric scintillation is caused by rapid variations in the electron density of the ionosphere. It manifests as rapid fluctuations in the amplitude and phase of radio signals traversing the ionosphere. In the case of navigation signals transmitted from satellites of the Global Navigation Satellite System (GNSS) ionospheric scintillation can cause a decrease in the accuracy of position estimation. During extreme fluctuations, a loss of lock on the satellites can occur, which can result in data outages. The ability to estimate the likelihood of ionospheric scintillation is of great importance for precision navigation applications such as GNSS assisted aircraft landing systems.

Dedicated GPS scintillation and total electron content monitors (GISTMs) sample the GNSS amplitude and phase at a high rate (20 - 50 samples per second) and then quantify the ionospheric scintillation in terms of the amplitude scintillation index (S₄) and the phase scintillation index (sigma;_{phi;}), which are based on the standard deviation of the amplitude and phase averaged over a period of 1 minute. The aim of this research is to derive proxies for ionospheric scintillation which can be obtained from ordinary dual frequency GNSS receivers, which are much more widely distributed than GISTMs, so as to develop regional maps of the occurrence frequency of ionospheric scintillation.

In this paper we present some preliminary results on the comparison of conventional scintillation indices to a scintillation proxy based on the rate-of-change-of-total-electron-content (ROT) derived from GNSS signals recorded by a receiver installed at Pwani University (Geo. Lon: 39.78deg;E, Geo. Lat: 3.24deg;S) in Kenya which is within the proximity of the southern equatorial ionization anomaly crest, a region of frequently occurring ionospheric scintillations. The ROTI-index, which is a scaled version of the standard deviation of ROT, is shown to correspond well to the S₄-index for moderate scintillations. It also has the ability to detect short-duration high amplitude scintillations that are not detected by the S₄-index.

Summary:

The paper presents a comparison of ionospheric scintillation proxies derived from high sampling rate GNSS data. The ROTI-index, which is a scaled version of the standard deviation of ROT, is shown to correspond well to the S₄-index for moderate scintillations. It also has the ability to detect short-duration high amplitude scintillations that are not detected by the S₄-index.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 50 / **260**

Characterization of the iThemba LABS segmented clover detector for gamma-ray tracking

Author: Wiseman Xolani[1]

Co-authors: Elena Lawrie [2]; Jayson Easton [3]; OBED SHIRINDA [2]; Sinegugu Happiness Mthembu [2]; Sive Noncolela [4]; Thifhelimbilu Daphney Bucher [2]; Tshepo Dinoko [2]

[1] *UNIZUL*

[2] *iThemba LABS*

[3] *iThemba LABS and University of the Western Cape*

[4] *UWC*

Corresponding Author: wxsmtshali@gmail.com

The iThemba LABS segmented clover detector is a new generation gamma spectroscopy detector and is made of four Ge crystals. Each crystal has one central electrode where a high voltage with positive polarity is applied, while the outside electrode is grounded and segmented 8-fold. When a gamma-ray interacts inside the detector it creates charges. These charges move towards the electrodes creating electric currents. The signals observed on the electrodes represent such currents and have shapes that are indicative where (i.e. how far from each electrode) the charge was created.

The determination of the interaction position in the detector requires both experimental and simulated data. A data base containing sets of simulated pulses that characterize every possible interaction position in the volume of the detector should be built first. The measured signals for gamma-ray interaction are then compared with the pulses in this data base. The interaction position is determined based on the best match of experimental pulses and pulses from the simulations.

Simulation of the pulses corresponding to different interactions has been done using Agata Data Library software (ADL). For each simulated gamma ray interaction ADL out-puts nine pulses per interaction, however it needs several parameters that have to be measured experimentally. In this work, response functions, crystal orientations and charge mobilities have been measured.
These parameters were then incorporated into the ADL code and the output traces corresponding to charge collection were compared to the experimental data. The results show good agreement. They will be presented and discussed.

Summary:

he iThemba LABS segmented clover detector is a new generation gamma spectroscopy detector and is made of four Ge crystals. Each crystal has one central electrode where a high voltage with positive polarity is applied, while the outside electrode is grounded and segmented 8-fold. When a gamma-ray interacts inside the detector it creates charges. These charges move towards the electrodes creating electric currents. The signals observed on the electrodes represent such currents and have shapes that are indicative where (i.e. how far from each electrode) the charge was created.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PHD

**Main supervisor (name and email)
and his / her institution**:

DR E.A Lawrie

iThemba LABS

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 34 / **261**

First-principles investigation of lattice thermal conductivity and stuctural stability of CH₃NH₃PbI₃

Author: Ibrahim Abdallah[1]

Co-authors: Daniel Joubert [2]; Mahammed Suleiman [3]

[1] *School of Physics and Mandelstam Institute for Theoretical Physics, University of the Witwatersrand*

[2] *School of Physics and Mandelstam Institute for Theoretical Physics, University of the Witwatersrand, Johannesburg, Wits 2050, South Africa.*

[3] *Department of Basic Sciences, Imam Abdulrahman Bin Faisal University, Dammam, KSA.*

Corresponding Author: ibraphysics@gmail.com

The stuctural stability, elastic constants, vibrational properties and lattice thermal conductivity of the orthorhombic CH₃NH₃PbI₃ have been investigated using first-principles calculations. These calculations were based on density functional theory and were performed using a generalized gradient approximation parametrized by Perdew, Burke and Ernzerhof (PBE and PBEsol). The relaxed system is dynamicaly satble, while the equilibrium elastic constants satisfy all the mechanical stability criteria for an orthorhombic structure, showing stability against small distortions. The lattice thermal conductivity was calculated with the single-mode relaxation-time approximation and a full solution of the linearized phonon Boltzmann equation from first-principles anharmonic lattice dynamics calculations. We found that the lattice thermal conductivity of CH₃NH₃PbI₃ is non-isotropic, with values of 0.134, 0.083, and 0.43 W m^{<i>-1</i>} K^{<i>-1</i>} in the directions <i>x</i>, <i>y</i> and <i>z</i>, respectively.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Daniel Joubert
daniel.joubert2@wits.ac.za
The National Institute for Theoretical Physics, School of Physics and Mandelstam Institute for Theoretical Physics,
University of the Witwatersrand, Johannesburg, Wits 2050, South Africa.

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Photonics / **262**

Diffusivity of single fluorescent probes embedded in thin polymer films

Author: Charmaine Sibanda[1]

[1] *Stellenbosch University*

Corresponding Author: charmainemusandu@gmail.com

Photophysics and photochemistry in polymer science has been of central areas of interest in understanding the structure and dynamics of polymers. The physical properties of polymers especially the dynamical properties close to the phase transition from rubbery to the glassy state are complex and have not been completely understood despite experimental and theoretical studies over the past decades [1]. Understanding the dynamics of polymer nano environments is highly crucial for numerous technological applications in various industrial and biomedical sectors related to protective and functional coatings and biocompatibility of medical implants [2]. The diffusivity of single probes embedded in thin polymer films can exhibit unusual physical properties due to geometric constraints imposed by the presence of surfaces and interfaces and using single molecule fluorescence microscopy as an imaging technique, allows one to look at the microscopic processes on the nanometer scale [3]. For this research single nanoparticles were embedded in thin polystyrene (PS) and poly (isobutyl methacrylate) (PIMA) films and were used to study the nano scale polymer dynamics via the diffusivity of the single nanoparticles. The diffusivity of the single nanoparticles was analyzed assuming a typical Brownian motion model that is used to calculate the mean square displacement of the single probes as a function of time, which in turn uniquely determines the diffusion coefficient of the single probes.

[1] R.A.Vallee et al. Single Molecule probing of glass transition phenomenon. Chemical Physics 2007,127, 15.
[2] B. Flier, et al. Heterogeneous Diffusion in Thin Polymer-Films as observed by High-Temperature Single Molecule Fluorescence Microscopy; J. Am. Chem. Soc., 2012, 134, 480-488.
[3] N. Tomczak et al. Probing polymers with single fluorescent molecules.European Polymer 2004,40, 1001-1011.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Msc

**Main supervisor (name and email)
and his / her institution**:

Dr Gurthwin Bosman
Stellenbosch University
gwb@sun.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 72 / **263**

Wide field fluorescence microscopy of single nanoparticles

Author: Charmaine Sibanda[1]

[1] *Stellenbosch University*

Corresponding Author: charmainemusandu@gmail.com

Single molecule fluorescence microscopy is a well known imaging technique used to image single probes in their nano environment. Optical studies of individual probes provide rare photo physical and photo chemical processes that are hidden in the ensemble average [1]. Fluorescence microscopy images are a source of information about the structure and the spatial distribution of a molecule of interest. The technique that was used for this research was wide field fluorescence microscopy. Using this technique requires that the whole sample be illuminated evenly by the source light as well as imaging the entire illuminated area [2]. In our work fluorescent signatures from single nanoparticles coated with rhodamine dye molecules were captured using a CMOS camera and was analyzed using an image processing software. To ensure that individual nanoparticles are imaged the sample solution concentration must be in the nano molar range, ensuring that the nanoparticles are sparsely spread over a glass cover slide. The image analysis also showed useful information on photo bleaching, photo stability and localization accuracy of the single nanoparticles.

[1] R. M. Dickson et al, "On/Off blinking and switching behaviour of single molecules of green fluorescent protein," Letters to Nature, vol. 388, pp. 355-358, 1997.
[2] F. Rost, Fluorescence microscopy volume 1, New York: Cambridge University Press, Cambridge& New York, 1995.

**Apply to be
 considered for a student
   award (Yes / No)?:**

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

Msc

**Main supervisor (name and email)
and his / her institution:**

Dr Gurthwin Bosman
Stellenbosch University
gwb@sun.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Nuclear, Particle and Radiation Physics 2 / 264

AdS/CFT predictions for partonic and fragmented momentum, azimuthal, and rapidity correlations of heavy flavors in heavy ion collisions

Authors: Robert Hambrock[1]; William Horowitz[1]

[1] *University of Cape Town*

Corresponding Author: roberthambrock@gmail.com

We compute the suppression, angular, and rapidity distribution of single open heavy flavour and the momentum, angular, and rapidity correlations for pairs of open heavy flavour at RHIC and LHC from an AdS/CFT-based energy loss model. We quantitatively compare these strongly-coupled QGP predictions to the weakly-coupled QGP predictions of Nahrgang et al., PRC90 (2014) [arXiv:1305.3823]. In the strong-coupling energy loss model, we include both the mean energy loss and thermal fluctuations; in the weak-coupling energy loss model, one set of predictions corresponds to the inclusion of purely collisional processes while the other additionally incorporates radiative corrections.

When restricted to leading order production processes, we find that the strongly coupled correlations of high transverse momentum pairs (>4 GeV) are broadened less efficiently than the corresponding

weak coupling based correlations, while low transverse momentum pairs (1–4 GeV) are broadened with similar efficiency, but with an order of magnitude more particles ending up in this momentum class. The strong coupling momentum correlations we compute account for initial correlations and reveal that the particle pairs suppressed from initially high momenta to the low momentum domain do not suffice to explain the stark difference to the weak coupling results in momentum correlations for 1–4 GeV. From this, we conclude that heavy quark pairs are more likely to stay correlated in momentum when propagating through a strongly coupled plasma than a weakly coupled one.

When initialised at next-to-leading order (POWHEG+Pythia8), we observe significant additional broadening of azimuthal correlations, with the angular correlations of low momentum pairs (1–4 GeV) essentially washed. However, the momentum correlations remain even when NLO production mechanisms are included. Thus, our conclusion for differences in momentum correlations with leading order production processes should carry over to next-to-leading order production processes once comparable predictions for a weakly-coupled QGP emerge.

Summary:

A key step in understanding the quark gluon plasma is identifying its relevant coupling strength. Finding observables that can distinguish between weakly and strongly coupled plasmas is thus very desirable. In this light, we compare the azimuthal and momentum correlations of $b\bar{b}$ pairs in Pb+Pb collisions ($\sqrt{s} = 2.76$TeV) of pQCD calculations and an AdS/CFT based energy loss model sensitive to thermal fluctuations. By accounting for initial momentum correlations as well, we gain further insight into the inherent differences in dynamics between the models.
Finally, we demonstrate that low momentum correlations (1-4GeV) serve as a potential distinguishing observable between weakly and strongly coupled plasmas.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Dr W.A. Horowitz
wa.horowitz@uct.ac.za
University of Cape Town

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 01 / **265**

Brillouin scattering study on the opto-acoustic anisotropy of SrF3

Author: Hlosani Dube[1]

Co-authors: Bhekumusa Mathe [1]; Daniel Wamwangi [2]

[1] *University of the Witwatersrand*

[2] *wits university*

Corresponding Author: bhekumusa.mathe@wits.ac.za

The elastic anisotropy of transparent polymer films and layers can be isanvestigated nondestructively using Brillouin scattering techniques. In this study, an application of Reflection Induced ΘA scattering (RIΘA) technique is introduced. In this geometry, we can simultaneously obtain RIΘA scattering and back scattering peaks in one frequency spectrum. Because the shift frequency of 180 scattering peaks are dependent on the refractive index, one can deduce the information of optical anisotropy (birefringence) by comparing the RIΘA and back scattering peaks. Making use of this idea, the elastic and optical properties (birefringence) of a strontium fluoride (SrF3) crystal are investigated. The refractive index of the SrF3 was then estimated using Brillouin scattering results from this isotropic plane.

**Apply to be
 considered for a student
   award (Yes / No)?**:

no

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

n/A

**Main supervisor (name and email)
and his / her institution**:

Bhekumusa Mathe
Bhekumusa.Mathe@wits.ac.za
University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Nuclear, Particle and Radiation Physics 2 / **267**

Search for new physics using four charged leptons at the LHC

Author: Mampionona Ralaimiaramanana RAJAOFERASON[1]

[1] *Wits University*

The production of four isolated charged leptons (electrons or muons) constitute a clean signature in proton-proton collisions provided by the Large Hadron Collider. A heavy scalar, H, with a mass around 270 GeV is considered as a scenario for the anomalous production of for leptons. The heavy scalar can decay directly into four leptons via the decay into two Z bosons. Another option is the decay of H into the Higgs boson and an intermediate scalar, S. The latter is assumed to have a relatively large branching fraction into leptons. The phenomenology and the status of the blinded data analysis will be summarized.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof. Bruce Mellado Garcia-School of Physics-Wits university

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 51 / **268**

LaBr_{text3} detector array for fast timing measurements

Author: Msebi Lumkile[1]

Co-authors: Ingeberg Vetle [2]; Jones Pete [3]; Sharpey-Schafer John [4]

[1] *(University of Westren Cape)*

[2] *University of Oslo*

[3] *iThemba Labs*

[4] *University of Western Cape*

Measurements of lifetime and transition moments for excited nuclear levels are fundamentally important in experimental nuclear physics since they reveal crucial properties of nuclear structure.
Recently a fast timing array has been assembled at iThemba LABS, Cape Town consisting of eight 2" by 2" LaBr_{text3} (Ce) detectors. Several experimental runs have been done with ²² Na and ⁶⁰ Co sources to effect calibration and efficiency measurements. A radioactive ⁶⁷ Ga source, produced at iThemba LABS, was placed at the centre 240mm equidistant from each detector in our fast timing array. The data collected was used to better understand fast timing techniques.
We present the present the results of efficiency measurements and some lifetime measurements for the 67Ga radioactive source.
More exciting work will done through the fast timing array in a quest to comprehend the population mechanism of excited 0⁺ states. Among the work to be carried out through this array, includes 0-degree measurements that are beneficial in suppression of high angular momentum values and selection of low spin states. All these endeavours will seek to unveil the quadrupole moment of nuclei and their intrinsic behavior .

**Apply to be
 considered for a student
   award (Yes / No)?:**

YES

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

PhD

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Nuclear, Particle and Radiation Physics 2 / 269

Constraining the Gluon Content of Nuclei with an Electron-Ion Collider

Author: Victor Gueorguiev[1]

Co-author: William Horowitz [1]

[1] *University of Cape Town*

Corresponding Author: grgvic001@myuct.ac.za

We present first results on the ability to constrain the gluon content of relativistic nuclei through novel light and heavy flavor jet and open heavy flavor observables at a future electron-ion collider (EIC), a \$1 billion dollar facility to be built in the United States. Using massive supercomputer processing, we compare predictions from a complete next-to-leading order Monte Carlo hard production and showering calculation for the jet and open heavy flavor spectra and correlations from multiple

state of the art nuclear parton distribution parameterizations including full Hessian uncertainty analysis. Our work will provide input into EIC detector design and will guide future theoretical research into the observation of non-linear properties of quantum chromodynamics (QCD).

Summary:

We present first results into constraining gluon content of relativistic nuclei using predictions from next-to leading order Monte Carlo calculations.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Hons

**Main supervisor (name and email)
and his / her institution**:

Dr. Will Horowitz; Senior Lecturer at the Department of Physics, University of Cape Town; Email: wa.horowitz@uct.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 52 / **270**

Firmware development of the ALICE MID readout card at the LHC

Authors: Nathan Boyles[1]; Sehlabaka Qhobosheane[2]

[1] *UCT, NRF/iThemba LABS*

[2] *NRF/iThemba LABS*

Corresponding Author: qhobosheanesb@tlabs.ac.za

ALICE (A Large Ion Collider Experiment) is the detector at the Large Hadron Collider (LHC) at CERN which is studying properties of the Quark-Gluon (QGP) Plasma using lead-lead (Pb-Pb), proton-proton (pp) and proton-lead (p-Pb) collisions. To cope with the increasing luminosity of the LHC, due to the need for more statistics and precision measurements of the QGP, the ALICE experiment is planning a major upgrade of its detectors during the Long Shutdown-2 (LS2) period, which is at present foreseen to start end of 2018. With the increased luminosity the detectors should be able to read out 50 kHz Pb-Pb collisions, and 200 kHz pp and p-Pb collisions at nominal performance. While some systems such as the ALICE Inner Tracking System will be replaced, most other detectors, including the Muon Spectrometer (Tracking and Trigger systems) will receive new front-end and readout electronics. This will allow all detectors to be read out at the expected interaction rates either upon a minimum-bias trigger or in a continuous mode. Central to this upgrade strategy is a new high-speed readout approach based on a Common Readout Unit (CRU). This unit is being developed for detector data readout, concentration and multiplexing onto the Online/Offline Computing farm (O2) for event reconstruction and storage, as well as distributing trigger and timing information to the on-detector electronics.

The ALICE Muon Identifier (MID) is the proposed future designation of the ALICE Muon Trigger System after LS2. The main task of the South African team at iThemba LABS is to develop and test the MID-specific code for the CRU FPGA (Field Programmable Gate Array) as part of the ALICE MID Upgrade and to coordinate these developments with the central ALICE CRU team. This poster presentation will focus on these activities.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Dr. Zinhle Buthelezi
zinhle@tlabs.ac.za
NRF/iThemba LABS

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 02 / **271**

Brillouin scattering study on the opto-acoustic anisotropy of SrF3

Authors: Bhekumusa Mathe[1]; Daniel Wamwangi[2]; Hlosani Dube[3]

[1] *University of the Witwatersrand*

[2] *wits university*

[3] *Wits Masters Student*

Corresponding Author: hlosani.dube1@students.wits.ac.za

The elastic anisotropy of transparent polymer films and layers can be investigated nondestructively using Brillouin scattering techniques. In this study, an application of Reflection Induced ΘA scattering (RIΘA) technique is introduced. In this geometry, we can simultaneously obtain RIΘA scattering and back scattering peaks in one frequency spectrum. Because the shift frequency of 180 scattering peaks are dependent on the refractive index, one can deduce the information of optical anisotropy (birefringence) by comparing the RIΘA and back scattering peaks. Making use of this idea, the elastic and optical properties (birefringence) of a strontium fluoride (SrF3) crystal are investigated. The refractive index of the SrF3 was then estimated using Brillouin scattering results from this isotropic plane.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Name: Bhekumusa Mathe
Email: Bermuda.Mathe@wits.ac za
Institute: School of Physics University of Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

N

Physics Education / **272**

Students' presentations as a teaching and learning tool

Author: Paul Molefe[1]

Co-author: Buyi Sondezi [1]

[1] *University of Johannesburg*

Corresponding Author: pmolefe@uj.ac.za

In an endeavour to increase throughput at the undergraduate level, we constantly search for ways of making learning fun as we emphasize conceptual understanding in our strategies. Traditional teaching style, where the lecturer has been the main figure in the class has been effective to some extent, while other students need variety. In making sure that students are effectively involved with the content of their courses throughout the semester, students presentations were introduced. Students were grouped and prepared in time to look at the specific topic that will be covered in their course. Each group had a specific section to cover, where each member in the group also had an opportunity to present. At the end of the presentations, questions were asked and clarity was given. Here we present the results of this method based on the marks obtained by students in those sections.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Space Science / **273**

Thermospheric winds and temperatures

Author: Michael Kosch[1]

Co-author: Mark Conde [2]

[1] *SANSA*

[2] *UAF GI*

Corresponding Author: mkosch@sansa.org.za

The Scanning Doppler Imager is a state-of-the-art Fabry-Perot interferometer system that allows remote ground-based "images" of thermospheric winds and temperatures using the Doppler shift and broadening of airglow emissions. Thermospheric winds at high-latitudes are generally driven by ion drag from ion convection as observed by the SuperDARN radars. The unique meso-scale imaging capability of this instrument has contributed to new discoveries, for example that auroras can directly influence the thermospheric wind velocity in time and space. Two Scanning Doppler Imagers were deployed to McMurdo and South Pole, Antarctica, in early 2016. The deployment and some preliminary observations are presented.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 78 / **274**

Lattice thermal conductivity of bulk WSe2

Author: Mahmoud Mahmoud[1]

Co-author: Daniel Joubert [1]

[1] *University of the Witwatersrand*

Corresponding Author: mahmoudalh1@gmail.com

Thermoelectric devices can convert heat into an electric current and have immense potential for efficient
use available energy. This includes converting heat energy from internal combustion engines, conventional
power plants and solar cells into usable energy. Research into finding efficient thermoelectric materials has
intensified over the past decade. One of the desired features of efficient thermoelectric materials is a low
lattice thermal conductivity. In other words, the thermal energy transported by the motion of the atoms in
a thermoelectric materials should be small. Recent research suggests that some layered materials may be
materials with this property. In this study we used first-principle calculations to investigate the structural,
electronic, and vibrational properties of bulk WSe2 , a layered material. The lattice thermal conductivity
was calculated by using a single-mode relaxation-time approximation in the linearized phonon Boltzmann
equation from first-principles an-harmonic lattice dynamics calculations. We find that the lattice thermal
conductivity of WSe2 is non-isotropic, with a value of 63.78 Wm−1K−1 in the direction of the plane and
2.39 W m −1 K −1 perpendicular to the plane at room temperature. The thermal conductivity perpendicular
to the plane is close to experimental value at room temperature, and is in a range which makes this an
interesting material as a potential active component in a thermoelectric device.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Professor D.P.Joubert
daniel.joubert2@wits.ac.za
School of Physics
University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Physics Education / **275**

Vectors from students' point of view

Author: Paul Molefe[1]

Co-author: Buyi Sondezi [1]

[1] *University of Johannesburg*

Corresponding Author: pmolefe@uj.ac.za

First year physics lecturers reported difficulties with students' learning of concepts and skills associated with studying vectors. The results of the investigation suggested that students had insufficient knowledge and understanding of magnitude, direction, and the significance of free-body diagrams in resolving the related vectors into components [1]. In the report [2], students were found to have knowledge of drawing free-body diagrams but lacked competence with the formulation of equations. The results revealed that most students did not do well in subsequent sub-questions. We report the findings obtained from the students when responding to the sources of their challenges in dealing with sections related to vectors.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Physics of Condensed Matter and Materials 1 / **276**

Density functional based tight binding (DFTB+) studies of pentlandites (Fe, Co, Ni)₉S₈ minerals

Author: Thabo Letsoalo[1]

Co-author: Phuti Ngoepe [1]

[1] *University of Limpopo*

Corresponding Author: thabo.letsoalo@ul.ac.za

Density functional based tight-binding method (DFTB+) is code which can calculate the small atoms electronic properties and molecular dynamics of large structures. We used parameterization techniques to study pentlandite minerals and large structure using a density functional based tight-binding (DFTB+) method. Pentlandite structures are the transitional-metal sulfides of the Fe, Ni group elements, and Co₉S₈being the only known binary phase. We developed sets of parameters for Co₉S₈, Fe₉S₈, Ni ₉S₈, and Fe₄Ni₅S₈mineral compounds. However Co-S, Fe-S, Ni-S and S-S interaction pairs produced a good bond lengths and the lattice parameters of these pentlandites minerals sulfides gave a good agreement of DFT-based calculations and experimental results. We calculated molecular dynamics on (1 1 1) surface Co₉S₈

nanoparticle from 300K to 1000K, and showed a zero band gap at a higher temperature. Supercell of pentlandite structure Fe₄Ni₅S₈ with 1864 atoms, the density of states (DOS) showed a band gap structure with a zero Fermi energy. We alloyed supercell of pentlandite structure Fe₄Ni₅S₈ of 1864 atoms with oxygen and changed the electronic properties with significance importance properties of pentlandites minerals.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Prof Phuti Ngoepe
Phuti.Ngoepe@ul.ac.za
University of Limpopo

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

no

Physics Education / **277**

FIRST-YEAR STUDENTS' DEVELOPMENT OF PHYSICS CONCEPTS: THE EFFECT OF GUIDED INQUIRY LABORATORY ACTIVITIES

Author: Vonani Baloyi[1]

Co-authors: E Gaigher [1]; W.E. Meyer [1]

[1] *University of Pretoria*

This study investigated the effect of guided-inquiry physics (GI) laboratory activities on students' development of physics concepts. Ninety seven first-year Bachelor of Science physics students participated in this study at a well-established South African university. The students were assigned systematically to control and experimental groups. The control group did recipe-based practical activities, while the experimental group did GI practical activities. At the end of the semester, data were collected using the written practical and hands-on examinations. Follow-up interviews were also conducted. Results indicated that some questions enhanced students' understanding of certain physics concepts while others did not. The control group outperformed the experimental group in many questions, but also performed worse in some of the questions. Overall, there were differences between experimental and control groups, although the differences were statistically insignificant. It was concluded that GI laboratory activities did not enhance first-year physics students' perceptions of physics concepts but it has enhanced positive attitudes towards physics laboratory work. The results of this study however, contribute to the understanding of current science laboratory practices, learning processes and the potential effects of inquiry-based instruction at university level.

**Apply to be
 considered for a student
   award (Yes / No)?**:

no

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

phd

**Main supervisor (name and email)
and his / her institution**:

Prof W.E.Meyer, walter. meyer@up.ac.za, University of Pretoria

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Poster Session 2 - Board: 73 / **278**

A Versatile Setup for Resonant Ionisation Spectroscopy of Atomic Species

Author: Brandon Hattingh[1]

Co-authors: Andre de Bruyn [2]; Christine Steenkamp [3]

[1] *LRI Stellenbosch*

[2] *Laser Research Institute, Stellenbosch University*

[3] *University of Stellenbosch*

Corresponding Author: brandondanehattingh@gmail.com

Resonant Ionisation Spectroscopy (RIS) is of growing interest as tool in the production and quality assurance of isotopes for medical applications. It is also a tool for precision investigation of exotic nuclei in many large nuclear physics facilities such as CERN. We report on the development of a versatile setup for tunable laser based atomic spectroscopy that will be used to investigate resonant ionisation schemes for different atoms and optimise the experimental parameters. RIS is a multi-step process of which the first 1 or 2 photons are resonant, and the last photon ionises the atom. Different spectroscopic methods will be investigated for characterization of the different steps: optogalvanic spectroscopy in a hollow cathode lamp, acoustic detection, absorption spectroscopy and laser induced (or reduced) fluorescence spectroscopy. The planned setup and preliminary results are presented.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Dr. Steenkamp cmsteen@sun.ac.za LRI Stellenbosch

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Photonics / **279**

Theoretical investigation of the Hong-Ou-Mandel interference in turbulence

Author: Chemist Mabena[1]

Co-authors: Filippus Roux [2]; Shashi Prabhakar [3]; Thomas Konrad [4]

[1] *University of the Witwatersrand and CSIR*

[2] *University of the Witwatersrand and NMISA*

[3] *University of the Witwatersrand*

[4] *UKZN*

The effect of turbulence on the Hong-Ou-Mandel (HOM) is analysed theoretically. The analysis is performed with two types of entangled input states, a Bell state and a spontaneous parametric down converted input state. In this work, two scenarios have been considered. The first scenario is when only one of the entangled photons is sent through the turbulence and the second scenario is when both the entangled photons are sent through turbulence. For the purpose of the calculations, we use a single phase screen approximation of the turbulent medium and a quadratic structure function to approximate the Kolmogorov theory of turbulence. The results show that the visibility of the HOM dip (or peak) is independent of the scintillation strength when only one photon goes through the turbulence for both types of entangled input states. However, in the case when both photons are sent through the turbulence, the visibility of the HOM dip (or peak) is reduced for increasing scintillation strength.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Name: Filippus Roux
email: FRoux@nmisa.org
Institution: School of Physics, University of the Witwatersrand and NMISA

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Physics of Condensed Matter and Materials 1 / 280

Non-specialist Talk - Structure Property correlation in SOFC & SOEC materials

Author: David Billing[1]

Co-authors: Caren Billing [1]; Roy Forbes [1]; Rudolph Erasmus [1]; Stuart Miller [1]

[1] *University of the Witwatersrand*

Corresponding Author: dave.billing@wits.ac.za

Solid Oxide Fuel Cells (SOFCs) and Solid Oxide electrolyser cells (SOECs) are exciting electrochemical devices that could provide unique and revolutionary solutions to some of the renewable energy challenges facing society. Central to the design of these devices is the need for a solid electrolyte that is an excellent oxygen ionic conductor whilst simultaneously being and electronic insulator. Additionally the materials needs to be mechanically tough and remain chemically inert in harsh operating environments. The architype materials used as solid electrolyte in most SOFCs include YSZ (Yttrium stabilised Zirconia) and CaSZ (Calcium stabilised Zirconia) with the Y or Ca dopants present at around 8 to 10% level.

In pursuit of improved materials for use in SOFCs and SOECs, our research has focused on gaining a fundamental understanding of the mechanisms governing the transport properties of these and closely related materials with an approximate A2B2O7 stoichiometry for various cationic ions, as well adding dopant species on particularly the A-site. Typically such materials adopt either average defect Fluorite or Pyrochlore structure types, and due to the presence of vacant anionic sites, both

these structure types have inherent potential for ionic conduction. Our research has included the development of suitable synthesis, preparation and processing methodologies, particularly for the more novel materials, followed by structural, crystallographic, electrochemical and spectroscopic characterisation. Noteworthy, as SOFCs and SOECs have operational temperatures ranging from around 300℃ to 1000℃, we perform XRD, PDF(1), Raman and EIS measurements between ambient to 900℃ or 1000℃. Consideration of the results obtained for the array of distinct materials we have prepared, has highlighted the central role of short range order, as well as the importance of microstructure on the overall transport properties of the materials.

I will present a selection of our results to date, including the results obtained from total scattering experiments performed on ID22 at the ESRF in Grenoble. Analysis of the data shows structural differences when comparing the structure as perceived on the nano-scale with the bulk average structure. The implications of this for the transport properties of all energy materials is profound, and will be described.

(1) S. J. L. Billinge, "Nanostructure studied using the atomic pair distribution function", Z. Kristallogr. Suppl. 26 (2007) 17-26

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Photonics / 281

Experimental investigation of the Hong-Ou-Mandel interference in turbulence

Author: Shashi Prabhakar[1]

Co-authors: Chemist Mabena [1]; Filippus Roux [2]; Thomas Konrad [3]

[1] *School of Physics, University of the Witwatersrand, Johannesburg 2000, South Africa*

[2] *NMISA, PO Box 395, Pretoria 0001, South Africa*

[3] *UKZN*

Corresponding Author: shashi.prabhakar@wits.ac.za

In this work, the effect of turbulence on the Hong-Ou-Mandel (HOM) effect is investigated experimentally. For this purpose, we produce entangled photonic states generated by spontaneous parametric down-conversion. In our experiment, the entangled photons propagate through different turbulent media, which are simulated using spatial light modulators. The atmospheric turbulence is simulated according to the Kolmogorov theory of turbulence and modelled as a single phase screen. Without any turbulence, one finds that symmetric states (anti-symmetric states) produce a dip (peak) in the coincidence counts, after passing through the beam-splitter, thanks to the HOM effect. With the addition of turbulence in one of the photon paths, we found that there is no change in the visibility of the dips or peaks. While in cases where the turbulence affects both photons, the visibility of the dip or peak is reduced. This phenomenon can be explained by the way in which the turbulence in a single-sided or doubled-sided channel affects the symmetry of the input state. Experimental results for all these various scenarios are presented.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Dr. Filippus S. Roux
froux@nmisa.org

NMISA, PO Box 395, Pretoria 0001, South Africa
School of Physics, University of the Witwatersrand, Johannesburg 2000, South Africa

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 53 / **282**

Fine structure of the Isoscalar Giant Monopole Resonance for 24Mg, 58Ni and 90Zr using 200 MeV α-particle inelastic scattering at zero-degrees

Author: Chané Simone Moodley[1]

Co-authors: ELIAS SIDERAS-HADDAD [1]; Frederick David Smit [2]; Iyabo Usman [3]; John Carter [1]; Kevin Li [4]; Lindsay Donaldson [5]; Luna Pellegri [6]; Paul Papka [7]; Retief Neveling [2]

[1] *University of the Witwatersrand*

[2] *iThemba LABS*

[3] *University of the Witwatersrand, Johannesburg.*

[4] *Stellenbosch University, iThemba Labs*

[5] *iThemba Laboratory for Accelerator Based Sciences*

[6] *University of Witwatersrand and iThemba LABs*

[7] *Stellenbosch University*

In the last decade, through high energy-resolution proton inelastic-scattering experiments, it was revealed that giant resonances carry fine structure as a signature of damping mechanisms. Now, for the first time, such high energy-resolution measurements can be made with intermediate energy α-particle inelastic-scattering at zero-degrees, where preferentially the Isoscalar Giant Monopole Resonance (ISGMR) is excited. These experiments have been performed using the Separated Sector Cyclotron (SSC) at the iThemba LABS and the K600 magnetic spectrometer for a range of nuclei including 24Mg, 58Ni and 90Zr. In order to isolate the electric monopole response, background from other multipoles can be subtracted including the Isovector Giant Dipole Resonance (IVGDR) and the Isoscalar Giant Quadrupole Resonance (ISGQR) using energy spectra also at zero-degrees obtained from proton inelastic-scattering. Following this multipole decomposition analysis, J π = 0+ level densities can also be extracted. Preliminary results will be presented.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Dr Iyabo Usman
Iyabo.Usman@wits.ac.za
University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 60 / **283**

Assessment of the quality parameters of corn cob for energy conversion through gasification

Author: Anthony Anukam[1]

Co-authors: Edson Meyer [1]; Sampson Mamphweli [1]

[1] *University of Fort Hare*

Corresponding Author: aanukam@ufh.ac.za

Corn cob is an abundant agricultural by-product of the maize industry, which is one of the largest producers of biomass residues in South Africa. The performance of energy conversion systems such as the gasification systems, among other factors, rely on the characteristics of the feedstock for conversion, which are most often determined by the use of specialized analytical instruments. This study assessed the characteristics of corn cob relevant to gasification in a downdraft system and determined that the physical, chemical and thermal as well as structural characteristics related to morphology and reactive group of atoms analyses are among the properties of corn cob that impacts its gasification performance. The results of these characteristics were interpreted in relation to gasification with specific reference to existing data from the literature. The calorific value result of corn cob showed that about 18 MJ/kg of energy is available for conversion. Its high ash content of approximately 9% indicates that technical difficulties linked to fouling, slagging and sintering effects may be experienced, which may together contribute to low gasification efficiency. However, the weight percentages of other properties such as moisture, volatile matter and fixed carbon contents as well as the three major elemental components (C, H and O) of corn cob including its clearly exhibited fiber cells, which are an indication of carbon-orientation as revealed by SEM analysis, makes corn cob a suitable feedstock for gasification. Its internal structural analysis as revealed by FTIR analysis showed that −OH, C−O, C−H and C=C are the major functional group of atoms in its structure. These groups facilitate the formation of condensable and non-condensable liquid and gaseous products that impacts on the quality of the syngas produced during gasification. TGA analysis also established the maximum decomposition temperature of corn cob, ranging from 94−900℃.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Sampson Mamphweli
smamphweli@ufh.ac.za
University of Fort Hare

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 03 / **284**

Effect of Cr3+ doping on structural, electronic and optical property of ZnGa2O4 for bio imaging application

Author: megersa kasim hussen[1]

Co-author: BF dejene dejene [1]

[1] *UFS*

Corresponding Author: megekasim@gmail.com

Effect of Cr3+ doping on structural, electronic and optical property of ZnGa2O4 for bio imaging application
Hussen M. K.*, Dejene B.F,
Department of Physics, University of the Free State (Qwaqwa Campus), Private Bag X13,
Phuthaditjhaba, 9866, South Africa
* Corresponding author: Tel: +27 58 718 5269; Fax: +27 58 718 5444;
E-mail:megekasim@gmail.com
Key words:ZnGa2O4 nanoparticles, Citric acid, Cubic, Blue emission,Bio-imaging
Abstract:This paper reports the material properties of undoped and Cr3+ -doped zinc gallate (ZnGa2O4) nanopowder synthesized by citric acid assisted sol-gel method doped with chromium of different molar concentrations (0.005– 0.025%).The XRD patterns revealedthat all the nano powders synthesized are cubic structured and Cr-doping did not affect the structure at all. The SEM micrographs show that nano powders are nearly spherical but became agglomerate with high doping of chromium concentrations. EDSmeasurement confirm the presence of the Zn, Ga, O and Cr ions.UndopedZnGa2O4nanopowder displace a broad blue emission but doping Cr ions caused the emission to occur in the near infrared region. An increase in Cr ions leads significantly enhancement in the NIR emission. The PL emission wavelength was also observed to dependent on the excitation wavelength and these nanomaterials can effectively be usedfor bio imaging application [1]. The TL intensity was recorded for different UV irradiation and it display a single broad glow curve while the glow the intensity is seen to increase with increasing UV expose time. The effect of different heating rates was also studied and is seen to cause peak temperature shifts. Repeated measurements on the same sample seem not to have any effect on peak temperature positions and TL intensity indicating the sample was stable.

Reference: [1] K. J. Lee, MSc thesis, Texas A&M University, 2005

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PHD

**Main supervisor (name and email)
and his / her institution**:

bfdejen@ufs.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Physics of Condensed Matter and Materials 1 / 285

Laplace transform deep level transient spectroscopy on n-type gallium arsenide

Author: Shandirai Tunhuma[1]

Co-authors: Danie Auret [1]; Jacqueline Nel [1]; Mmantsae Diale [1]

[1] *University of Pretoria*

Corresponding Author: malvenshandi@gmail.com

A review of the progress made on characterization of defects in n-GaAs using Laplace DLTS is presented. The technique offers up to an order of magnitude higher resolution than conventional DLTS. We explored the fine structure and annealing behavior of defects which would otherwise appear as single broad based peaks in conventional DLTS. Defects induced by several processes and incident irradiation from various radionuclides are presented. The information is vital for various opto-electronic applications of Gallium arsenide especially for space applications. EL2-like defects have great potential in the field of defect engineering.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Jacqueline Nel Jackie.Nel@up.ac.za University of Pretoria

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 61 / **286**

Performance Evaluation and Optimization of an Air Source Heat Pump Water Heater at Low Temperatures

Author: Joel YONGOUA NANA[1]

Co-authors: Michael Simon [2]; Stephen Loh Tangwe [3]

[1] *Fort Hare Institute of Technology*

[2] *FHIT*

[3] *Fort Hare Institute of Technology, University of Fort Hare*

Corresponding Author: joelnana1990@gmail.com

Residential air source heat pump (ASHP) water heaters can operate at a coefficient of performance (COP) between 2-4 under standard outdoor conditions. In winter usually at outdoor temperatures below 5℃ when their heating function is mostly needed, they tend to under-perform with COP usually close to 1. However, residential ASHP water heaters still offer room for further optimization in a bid to achieve a higher operation efficiency even at low temperatures from an energy management perspective.

In this work, we critically analyze the performance of a residential split-type ASHP water heater during winter at ambient temperatures below 5℃ (typical of South African climate during winter). The thermodynamic performance parameters and compressor energy consumption are modeled using multiple linear regression models. These models are then simulated in MATLAB incorporating an intelligent control algorithm designed to boost the COP at low ambient temperatures.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Michael Simon
msimon@ufh.ac.za
Fort Hare Institute of Technology

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 04 / **287**

Nanostructures growth on c-Si substrate by thermal dewetting of Pd and Al thin films

Author: Mamogo Masenya[1]

Co-authors: Francious Cummings [2]; Morgan Madhuku [3]; Sylvain Halindintwali [2]

[1] *Physics Department, University of the Western Cape, Private Bag X17, Bellville 7535, South Africa, iThemba LABS (Gauteng), Private Bag 11, WITS 2050, South Africa*

[2] *Physics Department, University of the Western Cape, Private Bag X17, Bellville 7535, South Africa*

[3] *iThemba LABS (Gauteng), Private Bag 11, WITS 2050, South Africa*

Nanomaterials are intensively researched due to a number of superior properties such as opto - electronic, mechanical, higher ratio of surface - to - volume ratio, etc. compared to those of their bulk counterparts. The objective of this study is to induce Si nanostructures by thermal dewetting of selected metals on c-Si substrate. Acid - etched and non - treated Si substrate were both useful in order to explore the effect of natives oxide on the growth of the nanostructures. Al and Pd thin film with thickness ranging between 5 and 20 nm were grown on c-Si (100) by electron beam evaporation. The films were thereafter isothermally annealed in vacuum at 580 0C for four hours and at 600 0C for two hours, for Al and Pd respectively. The induced nanostructures were characterized by SEM for both structural and elemental composition, XRD for phase transformation and crystallinity, UV-visible spectroscopy for optical properties and Hall effect measurements for electrical properties. Preliminary results show that while effective dewetting in individual droplets and larger island is achieved with Pd, Al induced nanostructures show small grains that evolve in much bigger coalesced but interconnected features. Our contribution will discuss the effect of the metal layer thickness as well as the effect of the native oxide on the induced nanostructures.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Dr M. Madhuku, madhuku@tlabs.ac.za, iThemba LABS
Dr S. Halindintwali, shalindintwali@uwc.ac.za, University of the Western Cape

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 05 / **288**

Effect of growth temperature on the structural, optical and luminescence properties of cadmium telluride nanoparticles

Author: Sharon Kiprotich[1]

Co-authors: Francis Birhanu Dejene [1]; Martin O Onani [2]

[1] *University of the Free State*

[2] *University of Western Cape*

Key words: Cadmium telluride; excitation; luminescence; optical properties; Crystallite size.
CdTe was synthesized by a simple wet chemical process at different reaction temperatures. Temperature is known to be a key thermodynamic factor that plays an important role in controlling the growth rate of the nanoparticle, the morphology, size and size distribution of the as-prepared CdTe nanoparticles. In this study, the effects of growth temperature on the structure and optical properties of CdTe nanoparticles were investigated in detail. X-ray diffraction (XRD) analysis displayed a cubic crystal structure with the plane 111, 200, 220, 311 being the main observed peaks. XRD pattern for samples prepared at temperatures lower than 50 ℃ had many impurities from unreacted precursors while those prepared at temperatures above 100 ℃ displayed polycrystalline nanoparticles. The photoluminescence (PL) spectra displayed a red shift (540 to 560 nm) in emission as growth temperature is increased from 50 to 200 ℃. Highest PL peak intensity was realized for growth temperature of 150 ℃. Absorption band maxima were observed to shift towards longer wavelength for higher growth temperatures. Spherical shaped nanoparticles were formed as displayed by the HRTEM and SEM images. The CdTe nanocrystals of different sizes caused tunable emission from green to red due to the quantum confinement effects and these nanomaterials can be applied for biomedical imaging [1].
Reference: [1] C. B. Murray, D. J. Norris, M. G. Bawendi, J. Am. Chem. Soc. 1993, 115, 8706 - 8715.

Summary:

Growth temperature was found to play a key role in the optical and structural properties of CdTe nanoparticles. The effects of the growth temperature was studied in order to know the optimum temperature required to prepare the CdTe nanoparticles for a desired applications.X-ray diffraction (XRD) analysis displayed a cubic crystal structure with the plane 111, 200, 220, 311 being the main observed peaks. XRD pattern for samples prepared at temperatures lower than 50 ℃ had many impurities from unreacted precursors while those prepared at temperatures above 100 ℃ displayed polycrystalline nanoparticles. The photoluminescence (PL) spectra displayed a red shift (540 to 560 nm) in emission as growth temperature is increased from 50 to 200 ℃. Highest PL peak intensity was realized for growth temperature of 150 ℃. Absorption band maxima were observed to shift towards longer wavelength for higher growth temperatures. Spherical shaped nanoparticles were formed as displayed by the HRTEM and SEM images. CdTe nanoparticles can be applied in a many optical devices and bioimaging due to its emission tunability.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Francis B Dejene
Dejenebf@ufs.ac.za
University of the Free State

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 74 / **289**

Investigating the insulator-metal phase transition in organic Cu(DCNQI)<sub>2</s salts by Ultrafast Electron Diffraction

Author: Nancy Payne[1]

Co-authors: Bart Smit [2]; Heinrich Schwoerer [1]

[1] *Stellenbosch University*

[2] *MSc Student*

Corresponding Author: nancy.elizabeth.payne@gmail.com

Ultrafast electron diffraction (UED) is used to study photo-induced structural phase transitions and dynamics in crystalline materials, with high temporal (sub-ps) and spatial (sub-Angstrom) resolution. Such research can offer insight into the interactions between the different vibrational and electronic degrees of freedom of the material.

The radical anion Cu-dicyanochino-diimine [Cu(DCNQI)₂] molecular crystals have metallic one-dimensional conductivities at room temperature. Particular chemical derivatives of Cu(DCNQI)₂ undergo a periodic lattice distortion (PLD) upon cooling, where the crystal layers along the conducting axis group into sets of three. The PLD is associated with the formation of a charge density wave (CDW) and a dramatic metal-to-insulator phase transition within 1 K, in some cases with a drop in conductivity of eight orders of magnitude. The insulator-to-metal phase transition can be optically driven, making Cu(DCNQI)₂ salts perfect candidates for UED experiments.

We study 50 nm thick, monocrystalline slices of Cu(Me,Br-DCNQI)₂, bulk needles of which undergo a metal-to-insulator phase transition at 155 K. Satellite peaks first appear upon cooling at approximately 165 K, evidence of the PLD and that the crystal has entered its insulating phase. Analysis of the satellite peak intensity and full width half maximum with respect to temperature suggest a gradual crystal layer displacement occurring in crystal domains, which grow together at lower temperatures. Once the sample is in its insulating phase, the insulator-to-metal phase transition can be optically induced. UED experiments show that upon pumping, the satellite peaks are fully suppressed within 2 ps and recover within 40 ps. That is, the PLD is fully reverted and the crystal enters its conducting phase within 2 ps, and recovers to the insulating state within 40 ps. This is accompanied by an ultrafast intensity redistribution of the Bragg peaks on a similar time scale, indicating structural changes in the organic molecules. Interpretation of the Bragg intensity changes will ultimately lead to a real-space 'molecular movie' of the dynamics within the crystal.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Heinrich Schwoerer, Stellenbosch University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 06 / **290**

Mechanical properties and temperature dependence of B19Ti_{50-x}Zr_x Pt₅₀ shape memory alloys

Author: Mordecai Mashamaite[1]

Co-authors: Hasani Chauke [2]; Phuti Ngoepe [2]

[1] *Materials Modeling Centre*

[2] *University of Limpopo*

A molecular dynamic study of Ti_{50-x} Zr_x Pt₅₀ as potential high temperature shape memory alloy has been performed using the LAMMPS code. The lattice dynamics, elastic properties and temperature dependence were deduced to determine the effect of ternary addition with Zr on the Ti sub-lattice at varied temperature range. It was found that the lattice parameter increases with Zr addition, the thermodynamic stability was observed at 5 at. % Zr. Furthermore, the elastic properties showed positive shear modulus for concentrations range 5 - 25 at. % Zr, indicating stability of the structures and instability above 25 at. % Zr concentrations. More importantly, we observed a martensitic transformation behaviour for Ti_{50-x} Zr_x Pt₅₀ (x= 3.125, 9.375) at around 900K.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. Hasani Chauke

hr.chauke@ul.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Photonics / 291

Ultrafast studies of lattice changes in organic Cu(DCNQI)₂ salts

Author: Nancy Payne[1]

Co-authors: Bart Smit [2]; Heinrich Schwoerer [1]

[1] *Stellenbosch University*

[2] *MSc Student*

Corresponding Author: nancy.elizabeth.payne@gmail.com

Ultrafast electron diffraction (UED) is used to study photo-induced structural phase transitions and dynamics in crystalline materials. UED uses the pump-probe technique: the sample is optically excited by a laser pulse and then its structure is probed by an electron pulse, effectively acquiring a sub-ps snapshot of the crystal structure in time. By changing the time delay between pump and probe, a ‘molecular movie’ of the induced dynamics can be built up. Such experiments require free-standing and ultrathin (<70 nm) samples.

An interesting candidate for study by UED is the radical anion salt Cu-dicyanochino-diimine [Cu(DCNQI)<sub>2</sub molecular crystals which exhibit extremely high, one-dimensional conductivities. Even more interesting, particular chemical derivatives of Cu(DCNQI)₂ undergo an abrupt metal-to-insulator (M-I) phase transition upon cooling, with a drop in conductivity of up to eight orders of magnitude within a single Kelvin. The M-I transition is associated with a periodic lattice distortion

(PLD) and the grouping of crystal layers along the conducting axis into sets of three. This structural change can be observed in electron diffraction patterns via the appearance of satellite peaks once the crystal has entered its insulating state. The chemical composition of the Cu(DCNQI)₂ salts is highly tuneable, with flexible choice of rest groups, metal ion and extent of deuteration. Changes in composition allow the conductivity and phase transition properties (i.e., the transition temperature) to be systematically and controllably tailored.

The insulator-to-metal phase transition can be optically driven by a laser pulse, thus the induced molecular dynamics can be studied with UED. We study Cu(Me,Br-DCNQI)₂, bulk needles of which have a transition temperature of 155 K. Analysis of the structural changes upon cooling (i.e., steady-state diffraction patterns) and upon photo-excitation (i.e., time-resolved diffraction patterns) will ultimately lead to a full molecular movie of Cu(Me,Br-DCNQI)₂ as it is pumped from its insulating to metallic phase.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Heinrich Schwoerer, Stellenbosch University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Applied Physics / 292

Identification of electrical breakdown sites in multi-crystalline Si solar cells

Author: Ross Dix-Peek[1]

Co-authors: Christiaan Pretorius [1]; Ernest van Dyk [1]; Frederik Vorster [1]

[1] *NMMU*

Corresponding Author: s212286552@nmmu.ac.za

Device material quality effects both the efficiency and the longevity of photovoltaic (PV) cells. Therefore, identifying defects can be beneficial in the development of more efficient and longer lasting PV cells. In this study, a combination of spatially-resolved, non-destructive techniques, including; electroluminescence (EL), infrared (IR) thermography and light beam induced current (LBIC) measurements, were used to locate and classify junction breakdown defects and features in multi-crystalline Si PV cells. The focus of this study is the identification of sites of junction breakdown in the PV cells under reverse bias using both Reverse Bias EL (ReBEL) and reverse bias IR thermography. The understanding of the behaviour of junction breakdown is important when characterising failures that result when cells operate in the bias regime when severely mismatched. This type of breakdown can have detrimental effects in PV plants and the performance of an entire 20-module string can be negatively impacted by a single cell that is mismatched and hence operating in its reverse bias regime.

Keywords: EL, IR thermography, LBIC, junction breakdown. PV cell

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof EE van Dyk
Ernest.vanDyk@nmmu.ac.za
NMMU

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 07 / **293**

Investigation of magnetic, morphological, structural, stability and optical properties of Ce3+ and Cu2+ co-doping in ZnO.

Author: WINFRED MUENI MULWA[1]

Co-author: FRANCIS BIRHANU DEJENE [1]

[1] *UNIVERSITY OF THE FREE STATE PRIVATE BAG X13 PHUTHADITJHABA, 9866*

Corresponding Author: mulwawinfred@gmail.com

Key words: Semiconductors, Electronic structure, Magnetic Properties, Optical properties
Abstract: Ce3+, Cu2+ co-doped ZnO (Zn1_2xCexCux O: x¼0.00, 0.01, 0.02, 0.03, 0.04 and 0.05) nanocrystals were synthesized by the use of sol-gel technique. These nanocrystals were investigated by using X-ray diffraction (XRD), UV–visible diffuse reflectance spectroscopy (DRS), scanning electron microscopy (SEM), High-resolution transmission electron microscope (HR-TEM) and selected area electron diffraction (SAED). The stability and magnetic properties of Ce3+ and Cu2+ co-doped ZnO were probed by first principle calculations. XRD results revealed that all the compositions are single crystalline, hexagonal wurtzite structure. The optical band gap of pure ZnO was found to be 3.22 eV, which was in agreement with other experimental findings [1, 2] and it decreased from 3.22 to 3.10 eV with an increase in the concentration of Cu2+ and Ce3+ content. The morphologies of Ce3+ and Cu2+ co-doped ZnO samples confirmed the formation of nanocrystals with an average grain size ranging from 70 to 150 nm. The ab initio magnetization calculations results affirmed the antiferro and ferromagnetic state for Ce3+ and Cu2+ co-doped ZnO structure.
Reference: [1] J.F. Chang, W.C. Lin, M.H. Hon, Appl. Surf. Sci. 183 (2001) 18.
[2] I. Djerdj, Z. Jaglicic, D. Arconde, M. Niederberger, , Nanoscale 2 (2010) 1096.

Summary:

Ce, Cuco-dopedZnOnanocrystals weresuccessfullysynthesizedbya microwavecombustionmethod.
With Ce–Cu co-doping,crystallite size, latticeparametersandstrainof ZnO changes.
The bandgapofthesynthesized samples hasbeenvariedintherange of 3.15–3.10eV.
The grainsizeofthesampleisde-creased withtheincreaseinCe–Cu co-doping.
The magnetizationmeasurements result intoferroandantiferromag-netic stateforallco-dopedsamples which isinagreementwith first principles theoreticalcalculations

**Apply to be
 considered for a student
   award (Yes / No)?**:

YES

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. Dejene Birhanu Francis

DejeneBF@ufs.ac.za
Department of Physics
University of the Free State- Qwaqwa campus
Private Bag X13 Phuthaditjhaba 9866
South Africa

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

YES

Poster Session 1 - Board: 62 / **294**

Application of Genetic Algorithm Parameter Optimisation on Current-Voltage data of multi-crystalline Silicon solar cells

Author: Ross Dix-Peek[1]

Co-authors: Christiaan Pretorius [1]; Ernest van Dyk [1]; Frederik Vorster [1]

[1] *NMMU*

Corresponding Author: s212286552@nmmu.ac.za

The models relating current and voltage for a diode and other related devices contain many parameters and the relations often contain multiple terms hindering explicit formulae for specific parameters. Optimisation procedures are useful for fitting a model to a dataset. In this study a Genetic Algorithm (GA) is proposed as the solution to the Parameter Optimisation (PO) of the models used to describe a solar cell. In particular, GAPO is applied to the current-voltage (I-V) relation of a multi-crystalline Si PV cell.

A GA is a type of Evolutionary Algorithm based upon biological processes such as genetic crossover during sexual reproduction, genetic mutation, breeding pair selection, and other such processes. GAs search the solution space with parallel proposed solutions, increasing the probability of convergence to a global minimum error for the parameters obtained for the applied model to the data. Alternatively, more classical approaches, such as the Gradient Descent parameter optimisation, are prone to acquiring only local minima. This paper addresses the application of GAPO in the parameter optimisation of a model applied (a multiple diode model) to the dark I-V curve of a Si solar cell, as well as the application of the technique on a model applied to (a hybrid model containing multiple diode terms to account for various factors) Light Beam Induced Current (LBIC) measurements which is used to spatially resolve device parameters of a Si solar cell. The GAPO used in this paper is constructed to ensure effective and relatively fast convergence to a global minimum while maintaining physically realisable values.

Keywords: Genetic Algorithm, parameter optimisation, LBIC

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof EE van Dyk
Ernest.vanDyk@nmmu.ac.za
NMMU

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Physics Education / **296**

A modern approach to Thermodynamics practicals

Authors: Ross Dix-Peek[1]; Ross Schultz[1]

Co-authors: Ernest van Dyk [1]; Ettienne Minnaar [1]; Frederik Vorster [1]; Lucian Bezuidenhout [2]

[1] *NMMU*

[2] *NMMU Physics Department*

Corresponding Author: s212286552@nmmu.ac.za

In the age of information and automation systems, students need to develop a skills set used in modern laboratories and industry. Innovative practicals can add another dimension to the education process by the application of the learnt theory in a real-life situation. In this paper, the utilization of skills sets commonly used at a postgraduate level are introduced to second year students to illustrate real world applications. Concentrating on the thermodynamics module content, students were introduced to the concepts of; 1) 3D design and modeling, where accurate relative measurements and calculations with regards to thermal expansion were conducted to build functional prototypes. 2) the use of custom-written LabVIEW programs for instrument control, data acquisition, digitization and visualization. This was done by controlling the boiling of water, plotting measured values and calculating thermodynamic properties such as rate of heating, thermal capacity, etc. 3) IR thermography by using a LabVIEW program, FLIR one thermal camera coupled to a smartphone was used to visualize heat flow across an aluminum cylinder. Combining the images with the measure elapsed time and temperature data as a function of distance, the heat flow rate was calculated. In addition, thermal imaging was illustrated for fault detection within circuitry and photovoltaic devices. Other standard thermodynamics practicals associated with concepts such as heat engines and Cp/Cv were also conducted using computerized data acquisition and analysed using Pasco's Capstone^{TM} software.
From these and other modernized practicals, the students showed an increased interest in continuing with Physics and also considering postgraduate Physics studies.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof EE van Dyk
Ernest.vanDyk@nmmu.ac.za
NMMU

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Applied Physics / **297**

Towards the Development of VCSEL-Based Time and Frequency Dissemination System using a DFB Phase Error Correction Actuator for the SKA

Author: Shukree Wassin[1]

Co-authors: Andrew Leitch [1]; George Isoe [2]; Romeo Reginald Gunther Gamatham [3]; Timothy Gibbon [4]

[1] *NMMU*

[2] *Centre for Broadband Communication,Nelson Mandela Metropolitan University*

[3] *NRF, Square Kilometre Array South Africa*

[4] *NMMU Physics Department*

The Square Kilometre Array (SKA) will be an interferometric, ultrasensitive radio astronomy instrument with an aperture array of one million square metres. The SKA telescope array will be coherently connected using optical fibre across an area of approximately 3000 km. A crucial and complex requirement for the SKA antenna is the coherent combination of the incoming astronomical data collected by the individual receptors remotely located. With recent progress and improvements made in atomic frequency standards, optical fibre is an attractive medium for stable and highly accurate timing and frequency transfer between a centralized location and multiple end-users. Precise and accurate clock tones will be distributed via optical fibre to the digitizers located on each antenna, thereby providing phase coherence within the telescopes array network. Natural temporal variations and external environmental conditions can affect the phase stability of the optical signal transmitted along the fibre. For this reason, an active fibre based time and frequency stabilization system is required. In this paper, a 22 km fibre round trip experiment described using a DBF phase correcting actuator. A 248.78 ps phase correction is applied to a 2 GHz clock signal at the transmitting end. Phase error correction to the distributed optical signal is achieved by exploiting the wavelength tunability of a distributed feedback (DFB) laser. Our proposed system has potential application in big data projects such as the Square Kliometre Array and various other frequency dissemination applications. Such systems can be employed into metro-access telecommunication networks.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Tim Gibbon
Tim.Gibbon@nmmu.ac.za
Nelson Mandela Metropolitan University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 09 / **299**

Investigation of defects in sputter deposition deposited Schottky barrier diodes on epitaxial GaAs by Laplace DLTS

Author: Fatemeh Taghizadeh[1]

Co-authors: Danie Auret [1]; Walter Meyer [1]

[1] *University of Pretoria*

Corresponding Author: fatemehtaghizadeh86@gmail.com

High resolution deep level transient spectroscopy (Laplace DLTS) was used to study Si doped n-type epitaxial GaAs. In this work, we used Au as the target material for the deposition of GaAs samples by sputtering deposition system. Three different doping densities of GaAs (1x10¹⁵ cm⁻³, 1x10¹⁶ cm⁻³ and 8x10¹⁶ cm⁻³) were deposited with 3 different powers 100 W, 150 W and 200 W for 10 minutes. From the Arrhenius plot, we found 3 defects with deferent energy levels (0.58 eV, 0.50 eV and 0.31 eV). The E_c- 0.50 eV defect is dopant dependent while the other two (0.58 eV and 0.31 eV) did not involve dopant atom. The E_c - 0.58 defect is bistable with the E_c - 0.31 eV defect, Under 0 V bias for 5 minutes, the E_c - 0.31 eV transforms to E_c - 0.58 eV and by applying the reverse bias the E_c - 0.58 eV transforms to E_c - 0.31 eV. This transformation is completely reversible. These results are the same as the results achieved by inductivity coupled plasma etching of GaAs [1]. The results from current-voltage measurements indicate that current reverse is a substantially higher compared to that of resistivity evaporated Schottky diodes.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Professor F.D.Auret

danie.auret48@gmail.com

University of Pretoria (UP)

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 10 / **300**

Influence of pH value on the material properties of the ZnO nanostructures using various solvents at constant temperature

Author: Francis Dejene[1]

Co-author: M A Tshabalala [1]

[1] *University of the Free State*

Corresponding Author: dejenebf@ufs.ac.za

Key words: Semiconductor, pH, ZnO nanoparticles, blue emmision
Abstract: ZnO nanoparticles were prepared by sol-gel process using various solvents. The sol-gel process is inexpensive, reliable, repeatable and simple. In this paper, we report the role of pH value on the structural and optical properties of ZnO nanoparticles. NaOH was used to vary the pH values of the precursors from 10 to 13.6. It is known that the nanoparticles are highly sensitive to surface environments such as water, moisture, humidity, pH and solvents. The pH affects the hydrolysis and

condensation behavior of the solution during gel formation and therefore influences the material properties of of the ZnO. SEM micrographs for the ZnO prepared using ethanol and methanol shows the agglomerated spherical ZnO nanoparticles of different sizes that are closely packed. The XRD patterns reveled wurtzite structure with three major peaks corresponding to (100), (002), and (101) planes which are indexed as JCPDS card no. 36-1451. The PL spectra display broad blue emissions that varied in intensity depending on the pH of the solution while peak position never changed. The UV absorption spectra of the ZnO prepared using methanol show a band edge around 248 nm and a weak band at around 282 nm for the pH values from 10.06 to 13.34. It is observed from the band gap spectra that when the pH value is 13.54, the band gap decreases but increases for the pH values between 10.06 and 13.34.

Reference: [1] K. J. Lee, MSc thesis, Texas A&M University, 2005

Summary:

N/A

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Physics of Condensed Matter and Materials 1 / 301

Elastic properties of chalcogenide based phase change memories by surface Brillouin scattering

Author: Daniel Wamwangi[1]

Co-authors: Bhekumusa Mathe [2]; David Billing [2]; Martin Salinga [3]; Matthias Wuttig [4]; Mmapula Baloi [2]

[1] *wits university*

[2] *University of the Witwatersrand*

[3] *Physics of New Materials, I. Institute of Physics, RWTH Aachen University*

[4] *Physics of New Materials, I. Institute of Physics, RWTH Aachen University, 52074 Aachen, Germany*

Corresponding Author: daniel.wamwangi@wits.ac.za

Chalcogenide based alloys continue to be intensively investigated as suitable candidates for universal memory applications. This is driven by their fast and reversible phase transitions (ns) and their scalability potential. Phase In this work the acoustic hardening of chalcogenide thin films on (100) Si is investigated to establish the changes in the bulk and shear modulus in the amorphous and crystalline phase by surface Brillouin scattering. X-ray Reflectometry has been used to extract film thickness and density requisite parameters for simulation of velocity dispersion curves. Surface Brillouin studies phase change samples have shown the Rayleigh surface acoustic wave and higher order guided modes thus indicating a case of a slow on fast film substrate configuration. The low surface roughness has been determined by X-ray Reflectometry to be less than 0.2nm for all the films. Applying the elastodynamic surface Green function approach determined the c11 and c44 in the range 40-30 GPa and 15 -10 GPa respectively.

**Apply to be
 considered for a student
   award (Yes / No)?**:

NO

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Poster Session 2 - Board: 11 / **302**

The effect of annealing temperature on the structure and luminescence of Zn2V2O7 prepared by sol-gel method

Author: Ketewe Foka[1]

Co-authors: Francis Dejene [1]; Hendrik Swart [1]

[1] *University of the Free State*

Corresponding Author: dejenebf@ufs.ac.za

Key words: Vanadate, Crystallinity, Thermogravimetric
Abstract: The zinc vanadate (Zn2V2O7) phosphor was prepared by a sol-gel method followed by annealing at temperatures between 700 ℃ - 850 ℃. The effect of annealing temperature on the structure and photoluminescence of Zn2V2O7 was investigated. The x-ray diffraction (XRD) results showed the single monoclinic phase of Zn2V2O7 [1]. The crystallinity of the Zn2V2O7 phosphor improved while the full width at half-maximum of (022) XRD peak was decreased with the increase in annealing temperature. Scanning electron microscopy (SEM) shows grain size increase with the increase in annealing temperature, which is due to the crystallinity of Zn2V2O7. Thermal behaviour of the Zn2V2O7 phosphor was investigated by thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC). TGA results showed a total weight loss of 65.3% when temperature was risen from 35 ℃ to 500 ℃. The photoluminescence (PL) emission spectra of annealed Zn2V2O7 powders showed a broadband emission from 400 nm to 800 nm. The PL intensity enhanced as the annealing temperature was increased, resulting to an improvement of the crystallinity. PL emission peaks shift from green emission towards a yellow emission.

Reference: [1] P. Y. Zavalij, F. Zhang and M. Stanley Whittingham, Solid State Sciences, 4 (2002) 591–597.

Summary:

None

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Theoretical and Computational Physics 1 / 303

Memory in non-Abelian Gauge Theory

Author: Bourgeois Gadjagboui[1]

[1] *Wits University*

Corresponding Author: bourgeois@aims.edu.gh

This project addresses the study of the memory effect. We review the effect in electromagnetism, which is an abelian gauge theory. We prove that we can shift the phase factor by performing a gauge transformation. The gauge group is U(1). We extend the study to the nonabelian gauge theory by computing the memory in SU(2) which vanishes up to the first order Taylor expansion.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Vishnu Jejjala, vishnu.jejjala@gmail.com, Wits University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Nuclear, Particle and Radiation Physics 1 / 304

Spectroscopy of proton unbound states in 32Cl.

Author: Mohamed Kamil[1]

Co-authors: Bernadette Rebeiro [1]; Bhivek Singh [1]; Deoin Steyn [2]; Frederick David Smit [2]; J Brummer [3]; Kevin Li [4]; Luna Pellegri [5]; Marín-Lámbarri Daniel José [6]; Nico Orce [1]; Paul Papka [3]; Philip Adsley [7]; Phumzile Mabika [1]; Retief Neveling [2]; Smarajit Triambak [1]; Vicente Pesudo [1]; Walid Yahia-Cherif [8]; ndinannyi justice mukwevho [9]

[1] *University of the Western Cape*

[2] *iThemba LABS*

[3] *Stellenbosch University*

[4] *Stellenbosch University, iThemba Labs*

[5] *University of Witwatersrand and iThemba LABs*

[6] *University of the Western Cape/ iThemba LABS*

[7] *University of Stellenbosch/iThemba LABS*

[8] *Universite des et de la Technolohie Houari Boumediene*

[9] *university of the western cape*

Corresponding Author: 3582611@myuwc.ac.za

The study of proton unbound states in 32Cl is important both in the context of nuclear structure and astrophysics. In this presentation we discuss the results from a recent experiment study of such states using the 32S(3He,t) reaction and the K600 spectrometer at iThemba LABS. Unbound protons from recoiling 32Cl nuclei were detected using the CAKE silicon array placed upstream of the target, while an attempt was made to detect weak gamma-rays from the relevant states using an array of NaI detectors.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof. Smarajit Triambak.
striambak@uwc.ac.za
University of the Western Cape.

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Space Science / **305**

A study on effects of geomagnetic extreme events in the middle atmosphere using Space-Borne Satellite and SuperDARN.

Author: Adila Wamisho Tire[1]

[1] *University of KwaZulu-Natal, NASSP node*

Corresponding Author: kinadila@gmail.com

Geomagnetic extreme events are geophysical phenomenons observed as a result of Sun's violent eruptive nature. As the Sun is the main driving factor of the atmosphere, there are vast number of works made to understand and explain the overall effects in dynamics, reaction and compositions of the atmosphere. But, due to the complexity of the interaction in the atmosphere it remains less understood. Events based studies help to easy the studies of the effects of geomagnetic storms in the middle atmosphere, this work presents effects of extreme storm events in the Mesosphere and Lower Thermosphere (MLT). A number of geomagnetic storm events are identified from satellite observations for this studies. Energetic particles precipitation data into the atmosphere, associated with storm events which may affect the atmospheric temperature and composition, obtained from NOAA Polar Orbiting Environmental Satellites (POES) measurements. SuperDARN, South African National Antarctic Expedition IV (SANAE IV) and its vicinity riometer data which are located in the Southern Hemisphere are employed to estimate ionospheric responses and conventions, and absorptions. Results show that extreme geomagnetic storms coupled with intensified energy absorption and possible middle atmosphere heating from the energy transport model calculations, which agrees with a number of well established results.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Sivakumar Venkataraman and Olakunle Ogunjobi

Venkataramans@ukzn.ac.za

School of Chemistry and Physics, University of KwaZulu-Natal, Durban, South Africa

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Nuclear, Particle and Radiation Physics 1 / **306**

High precision branching ratio measurement in ¹⁹Ne beta decay

Author: Bernadette Rebeiro[1]

Co-authors: Phumzile Mabika [1]; Smarajit Triambak [1]; TRIUMF 8pi collaboration [2]

[1] *University of the Western Cape*

[2] *TRIUMF, Vancouver, Canada*

Corresponding Author: b.rebeiro@gmail.com

At present there are several large scale experiments ongoing world-wide that aim to find experimental evidence of physics beyond the standard model (SM). Most of these experiments involve either deep underground low-background measurements or high-energy collider physics. An alternative method to look for signatures of new physics is via precision tests of fundamental symmetries assumed in the model. Precise measurements of observables such as decay rates and angular correlations in nuclear beta decays can be used to stringently test the assumed symmetries in the SM and to probe for exotic couplings, beyond the established V-A (vector – axial vector) picture of weak interactions.

In this presentation, we describe the analysis of data from a previous experiment performed at TRIUMF (Canada's National Laboratory for Particle and Nuclear Physics) to obtain the superallowed branching ratio for the beta decay of ¹⁹Ne to ¹⁹F using a radioactive ion beam. Together with a previously measured beta asymmetry parameter, the implications of our result pertaining to searches for right-handed weak interactions will be briefly discussed.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Smarajit Triambak, smarajit@gmail.com, University of the Western Cape, South Africa

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 12 / **307**

Structure-property correlation of thin films for energy applications

Author: Adam Shnier[1]

Co-authors: Caren Billing [1]; Daniel Wamwangi [2]; David Billing [3]

[1] *University of Witwatersrand*

[2] *wits university*

[3] *University of the Witwatersrand*

South Africa and the rest of the world have the challenge of a rapidly growing demand for energy. This leads us to seek out a low cost, high efficiency technology for energy generation which is easily scalable, such as hybrid organic-inorganic perovskite (HOIP) as well as other thin film energy materials. ^[1,2,3,4] HOIPs are held back by their limited stability, to which incremental progress has been made in literature. ^[3,4,5,6,7] As a preliminary study we investigated some HOIP devices and the thin films they are composed of, using X-Ray Reflectometry (XRR) and Electrochemical Impedance Spectroscopy (EIS), among other techniques for correlation between transport and structural properties. For a layered device XRR provides an interference pattern that is modeled to determine layer thickness, roughness and density. EIS can provide information about the impedance of the layers and the interfaces within a device; this is also determined by developing an appropriate model. This information can then be correlated to physical characteristics and/or processes. Selected results from our studies to date will be posted.

References
[1] Christians J A, Miranda Herrera P A, Kamat P V 2015 Journal of the American Chemical Society 137 1530–1538
[2] Krebs F C, Tromholt T, Jorgensen M 2010 Nanoscale 2 873-886
[3] Song Z, Watthage S C, Phillips A B, Heben M J 2016 Journal of Photonics for Energy 6(2) 022001-022001
[4] Tan H, Jain A, Voznyy O, Lan X, de Arquer FP, Fan JZ, Quintero-Bermudez R, Yuan M, Zhang B, Zhao Y, Fan F. 2017 Science 17 355(6326) 722-726.
[5] Yang J, Siempelkamp B D, Liu D, Kelly T L 2015 ACS Nano 9.2 1955-1963
[6] Zheng F, Saldana-Greco D, Liu S, Rappe A M 2015 The journal of physical chemistry letters 6 4862–4872
[7] Raga S R, Jung M-C, Lee M V, Leyden M R, Kato Y, Qi Y 2015 Chemistry of Materials 27.5 1597-1603

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof. Dave Billing
Dave.Billing@wits.ac.za
University of Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 13 / **308**

Influence of oxygen partial pressures on the structural and luminescence properties of pulsed laser deposited (Y-Gd)3 Al5O12:Ce3+ thin films

Author: PETER CHERUIYOT KORIR[1]

Co-author: FRANCIS BIRHANU DEJENE [1]

[1] *University of the Free State*

Key words: Yttrium Gadolinium Aluminate; Oxygen pressure; Photoluminescence; Crystal field.
Abstract: Yttrium Gadolinium Aluminate doped with Cerium (Y-Gd)3 Al5 O12: Ce3+) thin films

were grown on silicon wafer substrate by pulsed laser deposition technique (PLD) under oxygen atmospheres and substrate temperature of 300 ℃ during the film deposition process. The effect of oxygen partial pressures on the structural and luminescence properties of the as-deposited thin films were analyzed. XRD pattern showed that with increasing oxygen background gas pressure, the peaks in the direction (420) shifted to higher two theta angles as compared to the powder samples. This could be attributed to induced crystal field effects on the host due to the different ionic sizes of Gd3+(r =105 nm) compared with Y3+(r =102 nm). Scanning electron microscopy (SEM) confirmed that oxygen background gas pressure affected the morphology of the films. The photoluminescence (PL) emission spectra showed a broad band emission ranging from 470 to 600 nm with a maximum at 545 nm when excited with 467 nm UV due to the 4f-5d electronic transition of Ce3+ attributed to the delocalization of electrons from the lowest 5d level to the crystal field split 4f (2F5/2, 2F7/2) levels of Ce3+. A slight shift in the wavelength of the PL spectra was observed from the thin films when compared to the PL spectra of the phosphor in powder form. The PL intensities of the films are generally low in all the (Y-Gd)3 Al5 O12: Ce3+) thin films samples compared to those of the powder. Reference: [1] S. Dlamini, H. C. Swart, J. J. Terblans, O. M. Ntwaeaborwa, Solid State Sci 2013; 23: 65–71.

Summary:

N/A

**Apply to be
 considered for a student
   award (Yes / No)?**:

YES

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof DEJENE
DejeneBF@ufs.ac.za
University of the Free State (Qwaqwa Campus)
Department of Physics.
Phuthaditjhaba 9866
South Africa.

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

YES

Physics of Condensed Matter and Materials 1 / 309

Computational Modelling Study on Stability of Li-S/Se System

Author: Cliffton Masedi[1]

Co-authors: Happy Sithole [2]; Phuti Ngope [3]

[1] *UL/CSIR*

[2] *CSIR*

[3] *UL*

Corresponding Author: cmasedi@csir.co.za

Li-ion batteries have transformed portable electronics and will play a key role in the electrification of transport. However, the highest energy storage possible for Li-ion batteries is insufficient for the long-term needs of society. Here we consider a study on rechargeable lithium–sulfur (Li–S) batteries which hold great potential for high-performance energy storage systems because they have a high theoretical specific energy, low cost, and are eco-friendly. This work employs computational modelling methods to explore stability, structural and electronic properties of discharge products formed in the Li-S/Se battery, especially Li₂S/Se, which has potential to offer higher theoretical specific energy and remedies the challenges that Li-S battery encounters. First principle methods were used to calculate thermodynamic properties of Li₂S and Li₂Se, which agreed with available experimental results. A cluster expansion technique generated new stable phases of Li₂S/Se system and Monte Carlo simulations determined concentration and temperature ranges in which the systems mix. Interatomic Born Meyer potential models for Li₂S and Li₂Se were derived and validated and used to explore high temperature structural and transport properties of Li₂S/Se.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Ngoepe P.E
phuti.ngoepe@ul.ac.za
UL, MMC

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Nuclear, Particle and Radiation Physics 2 / 310

Geometrical Validation of ATLAS New Small Wheel Simulation Software

Author: Chilufya Mwewa[1]

[1] *University of Cape Town*

Corresponding Author: chilufya@aims.ac.za

The Large Hadron Collider (LHC), the largest hadron accelerator ever built, began operations in 2009 at centre-of-mass energies of 0.9, 7 and 8 TeV (Run I). After a long shutdown (LS1) of two years (2013-2014), the LHC resumed operations in 2015 (Run II) at a centre-of-mass energy of 13 TeV and reached a record luminosity of 1.37 x 10ˆ34 cm-2 s-1, exceeding its design luminosity of 10ˆ34 cm-2 s-1. In addition, it is expected to reach a centre-of-mass energy of 14TeV by the end of Run II (2018). Thereafter, the LHC will undergo another shutdown (LS2) in preparation for even higher luminosity scenarios during Run III. Such high luminosities are anticipated to affect, among other things, the tracking and triggering of muons in the ATLAS detector's muon spectrometer due to high counting rates (mostly from increased cavern background) and fake high transverse momentum tracks. To address this issue, the ATLAS collaboration will replace the innermost stations in the muon spectrometer end caps (Small Wheels) with a set of precision tracking and trigger detectors capable of handling high rates - the New Small Wheels (NSW). The NSW design is proposed to have two types of detector technologies: Small Strip Thin Gap Chambers for triggering and Micro Mesh Gas Structures for precision tracking. The performance of the NSW at these high rates is currently being studied in simulations. A validation study to check how well the simulation software depicts the geometry of the NSW detector planes is presented here.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Dr Sahal Yacoob, sahal.yacoob@uct.ac.za or Sahal.Yacoob@cern.ch
University of Capetown

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Nuclear, Particle and Radiation Physics 2 / 311

Higgs decay via the dark vector boson to four leptons

Author: Phineas Ntsoele[1]

Co-author: ATLAS Collaboration [1]

[1] *University of Johannesburg*

Corresponding Author: shconnell@uj.ac.za

The Standard Model (SM) is known to be incomplete (it cannot explain dark matter, dark energy, gravitational waves, matter-antimatter asymmetry, etc). The introduction of a Dark Sector via an additional U(1)_D gauge symmetry added to the SM Lagrangian could be the long-awaited solution. In this model there is a dark vector boson Z_d which can mix with the SM hypercharge gauge boson. This opens the Hypercharge Portal which can mediate the fluctuation of a Z to a Z_d, or the decay of the Z_d to SM leptons. If a dark Higgs singlet also exists, this then breaks the U(1)_D, opening the Higgs portal and also allowing for Higgs mass mixing between the SM and dark sectors. Including dark fermionic fields in the Lagrangian allows for long-lived cold Dark Matter candidates. The various connections between the Dark and SM sectors allow descriptions of many key astro-physical phenomena. The Model is therefore a fascinating candidate for new physics beyond the SM. It becomes crucial to search for experimental signatures of this model. This contribution discusses a search for the dark force boson Zd using its production via the Higgs Portal and its decay back to SM leptons: H ⟶ h_d⟶ Z_dZ_d ⟶ 4l.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

SH Connell
University of Johannesburg

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Nuclear, Particle and Radiation Physics 1 / 312

ASSESSMENT OF ANNUAL EFFECTIVE, DOSES FROM ENVIRONMENTAL TERRESTRIAL GAMMA RADIATION AND IN DANGOTE

CEMENT INDUSTRY, IBESE OGUN- STATE NIGERIA

Author: Kehinde Olatunji[1]

Co-author: Lateef Bamidele [1]

[1] *Department of Science Laboratory Technology , Osun State College Of Technology, Esa-Oke,Osun State Nigeria*

Corresponding Author: kehindeolat@gmail.com

Terrestrial gamma radiation dose rates of Dangote cement industry Ibese Ogun state were measured using Digilert200. The mean outdoor terrestrial gamma dose rate is 137.16nGy/h with a range of 104.4nGy/h to 159.6nGy/h. Also, the annual effective dose ranged from 0.1600mSv/y to 0.2446mSv/y with a mean value of 0.210mSv/y. This value of mean annual effective dose of 0.210mSv/y is well below 1mSv/y maximum permissible limit for the public, set by International Commission on Radiological Protection (ICRP). This indicate that the people living and working within the area are safe and are not exposed to high doses of radiation as a result of activities in the industry.

KEYWORDS: Radionuclides, Ibese, Effective dose, Digilert200, Environmental, Dose rate

**Apply to be
 considered for a student
   award (Yes / No)?:**

NO

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Astrophysics / 313

Gamma-ray Pulsars - A Cosmic Treasure Chest

Author: Christo Venter[1]

[1] *North -West University*

Corresponding Author: christo.venter@nwu.ac.za

The number of gamma-ray pulsars has been steadily increasing since the launch of the Fermi Large Area Telescope in 2008, which was the catalyst for a great number of new pulsar detections. These rapidly rotating neutron stars exhibit rich phenomenology, indicating that there are still many unsolved mysteries regarding the magnetospheric conditions in these stars after 50 years of research. Indeed, this year marks the golden anniversary of the discovery of the first radio pulsar, and theorists and observers alike are looking ahead to another half-century of discovery, with many new experiments coming online in the next decades. In this talk, I will give an overview of recent pulsar observations and describe their multiwavelength properties. I will also briefly allude to some theoretical models that provide a framework within which to make sense of these extreme cosmic light houses.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Applied Physics / 314

Kinetics of essential oil extraction from castor seeds and macadamia nuts

Author: Antoine-Floribert MULABA-BAFUBIANDI[1]

Co-authors: Jonathan Kiaka [2]; Sharon Makgoga [3]

[1] *School of Mining, Metallurgy and Chemical Engineering, University of Johannesburg*

[2] *Mineral Processing and Technology Research Centre*

[3] *University of Johannesburg*

Corresponding Author: amulaba@uj.ac.za

Macadamia nuts and castor seeds are some of the popular sources of essential oils. Oil extraction from these two natural products can be effected by both cold pressing and solvent extraction or a combination of the above. In this work both raw materials, extraction mechanisms and kinetics of essential oils production from their seeds using different techniques will be discussed. The kinetics of essential oil extraction from castor seeds and macadamia nuts would be affected by different factors (size of the seeds/nuts, hardness, integrity of the seeds/nuts, temperature, pressure and concentration of the extraction medium). Data collected during the oil extraction process are discussed in the light of existing kinetics models. Whether first order or not argumentation will be made.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Antoine F. Mulaba-Bafubiandi
amulaba@uj.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Full

Poster Session 2 - Board: 54 / **315**

(p,t) reactions on Barium isotopes and neutrinoless double beta decay.

Author: Jespere Calderone Nzobadila Ondze[1]

Co-authors: Alejandra Diaz Varela [2]; Badamsambuu JIGMEDDORJ [3]; Bernadette Rebeiro [1]; Christina Burbadge [2]; Gordon Ball [4]; Hans Wirth [5]; Kyle LEACH, [6]; Paul Garrett [2]; Ralph Hertenberger [5]; Smarajit Triambak [1]; Thomas Faestermann [7]; Vinzenz Bildstein [2]; Zandile Mabika [1]

[1] *University of the Western Cape*

[2] *University of Guelph*

[3] *(University of Guelph)*

[4] *TRIUMF*

[5] *Ludwig-Maximilians-Universitat Munchen*

[6] *(Colorado School of Mines)*

[7] *Technische Universitat Munchen*

Corresponding Author: jespereondze@gmail.com

The massive nature of neutrinos opens the possibility that they could be Majorana fermions (the neutrino being the same as its antiparticle). The observation of a neutrinoless double beta (0&nußß) decay will validate this possibility and its measured decay rate will determine the absolute neutrino mass scale. However, if the latter were observed, there still exists a large uncertainty on the calculated transition matrix elements for double beta decay candidates that will affect the determination of the neutrino mass.Having a better understanding of the structure of these nuclei greatly help constrain these calculations. In this poster we describe the study of (p,t) reactions on ¹³⁶Ba and ¹³⁸Ba initiated at the University of the Western Cape in order to obtain useful nuclear structure information for the double beta decay matrix element calculations of ¹³⁶Xe to ¹³⁶Ba.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Smarajit Triambak, smarajit@gmail.com,University of the Western Cape, South Africa

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 63 / **316**

Design, construction and performance evaluation of a greenhouse temperature regulated, agitated portable biogas digester

Author: Asheal Mutungwazi[1]

Co-authors: Golden Makaka [2]; Patrick Mukumba [2]

[1] *UFH/FHIT*

[2] *UFH*

Corresponding Author: amutungwazi@gmail.com

Biogas technology has a high potential to meet the domestic, medium and large-scale facility energy needs of South Africa. Many digester designs, which include the different models of the fixed dome, balloon and floating drum digesters, have been installed in the country for more than sixty years. The effects of low temperatures during cold seasons and nights, temperature fluctuations, the high cost of electrical heating, infeasibility of digester installation in rocky and mountainous terrains, inefficient agitation and difficult maintenance experienced in the use of most of the installed digester designs are common challenges associated with the biogas technology. In this research, a 100 litre, semi-continuously fed and agitated portable digester whose operation temperature is automatically maintained at an optimum of 35 ± 0.5℃ and a pH of 6.8-7.2 within a thermodynamically sized greenhouse by means of a temperature sensitive thermal piston for venting control through a suitably sized window was designed and tested. The digester has an anchor impeller for intermittent mixing of the substrate slurry. The cowdung used had a total solids(TS), volatile solids

(VS), chemical oxygen (COD and ammonia nitrogen content of 151 mg/L, 33.6 mg/L, 2235 mg/L and 698 mg/L respectively. Analysis of the biogas produced showed a specific biogas yield of 0.582 m³/kgVS_{added} and a methane content of 64% using cow dung as substrate. The benefits of high methane production and digester design suitability in any setting i.e. rural, urban, rocky or smooth areas offered by this design will lead to a faster dissemination of the biogas technology. The design is also in intimate alignment with the South African Integrated Resource Plan (IRP) national strategy of 2010.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof. Golden Makaka
gmakaka@ufh.ac.za
University of Fort Hare

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Theoretical and Computational Physics 1 / 317

Heavy Flavor Tagged Photon Bremsstrahlung from AdS/CFT

Author: William Horowitz[1]

[1] *University of Cape Town*

Corresponding Author: wa.horowitz@uct.ac.za

We compute for the first time the near-side photon bremsstrahlung spectrum associated with open heavy flavor propagating through a strongly-coupled quark-gluon plasma. We expect that this observable will show measurably distinguishable differences between the soupy slowdown in AdS/CFT compared to the sporadic stiff smacks from a weakly-coupled pQCD plasma gas. Assuming the heavy quark loses energy from the usual AdS/CFT drag setup we find that small angle photon radiation is suppressed in medium compared to vacuum while wide angle radiation is enhanced.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 14 / **318**

The effect of sample purity on the charge density wave compound TiSe₂

Author: Chani van Niekerk[1]

Co-authors: Bryan Doyle [2]; Emanuela Carleschi [3]; Luca Pasquali [4]

[1] *Student*

[2] *University of Johannesburg*

[3] *Department of Physics, University of Johannesburg*

[4] *Dipartimento di Ingegneria "Enzo Ferrari", Università di Modena e Reggio Emilia, via Vignolese 905, 41125 Modena, Italy*

Corresponding Author: chanivanniekerk@gmail.com

We have investigated the electronic structure of the charge density wave (CDW) compound TiSe₂ using detailed X-ray photoelectron spectroscopy (XPS) measurements from the core levels (Ti 2p, Se 3p and Se 3d), as well as the valence band. Four different samples were provided to us by collaborators at the University of Bath, in addition to corresponding resistivity measurements. Each batch has different sample purity and thus stoichiometry, due to different growth conditions. The four samples were studied in their cleaved and uncleaved forms, after which they were stored in air and reinvestigated. XPS data were obtained at room temperature using two different photon energies (hnu; = 1486.71 eV and 2984.3 eV), so that the contribution to the electronic structure of both the surface and bulk of the samples could be probed.
It was found that the cleanliness of the sample surface lasts for approximately 24 hours with minimal contamination in vacuum, and that air storage affects the contamination to a large degree. Using the data obtained, the Ti:Se stoichiometry of each sample was determined. These results were compared to the transport properties measurements provided. As expected, the resistivity depends largely on the growth conditions – hence the sample purity. The resistivity curve of the purest sample batch peaks at a critical temperature of 202 K, which corresponds to the CDW transition temperature. When comparing the stoichiometry found using XPS to the resistivity curve, it was found that a deviation of 5-10 % from the 1(Ti):2(Se) expected stoichiometry resulted in a lowering of the CDW transition temperature to 125 K. So in agreement with the expected results, the more pure the sample was found to be, the closer the peak in the resistivity is to the maximum CDW transition temperature.
In the future we will use angle resolved photoelectron spectroscopy in order to investigate the effect of stoichiometry and sample purity on the low-energy electronic structure features displayed by the same samples. We foresee that this will shed light on the controversial debate on the structure of the CDW phase reported for TiSe₂ and the fact that that it may be a 2x2x1 structure as opposed to the previously assumed 2x2x2 structure.

Summary:

The electronic structure of the charge density wave (CDW) compound TiSe₂ using detailed X-ray photoelectron spectroscopy (XPS) measurements from the core levels (Ti 2p, Se 3p and Se 3d), as well as the valence band. Four different samples, each with different purity and stoichiometry, were provided to us by collaborators at the University of Bath, in addition to corresponding resistivity measurements. XPS data were obtained at room temperature using two different photon energies (hnu; = 1486.71 eV and 2984.3 eV).
It was found that the cleanliness of the sample surface lasts for approximately 24 hours with minimal contamination in vacuum, and that air storage affects the contamination to a large degree. The Ti:Se stoichiometry of each sample was determined and the results compared to the transport properties measurements provided.
The resistivity depends largely on the growth conditions – hence the sample purity. The resistivity curve of the purest sample batch peaks at a critical temperature of 202 K, which corresponds to the CDW transition temperature. When comparing the stoichiometry found using XPS to the resistivity curve, it was found that a deviation of 5-10% from the 1(Ti):2(Se) expected stoichiometry resulted in a lowering of the CDW transition temperature to 125 K. So in agreement with the expected results, the more pure the sample was found to be, the closer the peak in the resistivity is to the maximum CDW transition temperature.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Emanuela Carleschi
Department of Physics, University of Johannesburg, PO Box 524, 2006 Auckland Park, South Africa
Email: ecarleschi@uj.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Nuclear, Particle and Radiation Physics 1 / 319

The Characterization of the first excited ½⁺ state in ⁹B

Author: ndinannyi justice mukwevho[1]

Co-authors: Bernadette Rebeiro [2]; Deoin Steyn [3]; Elijah Akakpo [2]; Frederick David Smit [3]; Kevin Li [4]; Luna Pellegri [5]; Marín-Lámbarri Daniel José [6]; Nico Orce [2]; Paul Papka [7]; Philip Adsley [8]; Phumzile Mabika [2]; Retief Neveling [3]; SANDILE JONGILE [9]; Smarajit Triambak [2]; Walid Yahia-Cherif [10]; fhumulani nemulodi [3]; mohamed mohamed [11]; vicente Pesudo [6]

[1] *university of the western cape*

[2] *University of the Western Cape*

[3] *iThemba LABS*

[4] *Stellenbosch University, iThemba Labs*

[5] *University of Witwatersrand and iThemba LABs*

[6] *University of the Western Cape/ iThemba LABS*

[7] *Stellenbosch University*

[8] *University of Stellenbosch/iThemba LABS*

[9] *UNIVERSITY OF ZULULAND*

[10] *ence et de la Technologie Houari Boumediene/ iThemba LABS*

[11] *university of western cape*

Corresponding Author: mukwevhondina@gmail.com

The ⁹Be - ⁹B isospin doublet carries fundamental significance for both nuclear structure and nuclear astrophysics studies. The first excited ½⁺ state in ⁹Be is already well established. However, its isobaric analogue state in ⁹B has not been unambiguously determined yet. Theoretically, the ⁹B nucleus can either be described using a cluster model with two unbound α particles held together by a covalent proton or using the shell model as a ⁸Be core + proton in the s-d shell. Both theoretical predictions based on different models as well as experimental investigations yield largely discrepant results for the excitation energy of this state.

This presentation describes preliminary results from an experiment performed at iThemba LABS that aimed to characterize the first ½⁺ state in ⁹B with the ⁹Be(³He,t) reaction at the K600 spectrometer.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Smarajit Triambak
smarajit@gmail.com
University of the Western cape
South Africa

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 64 / **320**

Transmission performance of 10 Gbps OOK, 15 Gbps 2-PAM and 20 Gbps 4-PAM data signals over 11 km using a 1310 nm VCSEL

Author: George Isoe[1]

Co-authors: Andrew Leitch [2]; Duncan Boiyo [3]; Romeo Reginald Gunther Gamatham [4]; Shukree Wassin [2]; Timothy Gibbon [5]

[1] *Centre for Broadband Communication,Nelson Mandela Metropolitan University*

[2] *NMMU*

[3] *Centre for Broadband Communication, Nelson Mandela Metropolitan University*

[4] *NRF, Square Kilometre Array South Africa*

[5] *NMMU Physics Department*

Corresponding Author: george.isoe@live.nmmu.ac.za

Abstract: Current optical access network use on-off keying (OOK) modulation format throughout the network regardless of actual end user demand. We propose the use of two pulse amplitude modulation (2-PAM) and 4-PAM formats to increase the aggregated data rates of optical access networks. In this work, we experimentally evaluate the realization of a high capacity passive optical network using 1310 nm vertical cavity surface emitting lasers (VCSELs) in the OOK, 2-PAM and 4-PAM modulation formats. An 11 km of G.652 standard fibre transmission was experimentally investigated at 10 Gbps, 15 Gbps and 20 Gbps data rates per channel for OOK, 2-PAM and 4-PAM modulation formats respectively. An 11 km fibre transmission introduced a penalty of 0.46 dB and 3.45 dB incurred for the 10 Gbps OOK and 15 Gbps 2-PAM formats. However, for the 20 Gbps 4-PAM format, the maximum reach was limited to 3.21 km due to inter-symbol interference at such a high bit rate. All measurements were done in real time and without any data equalization mechanism. The experimental comparison showed that the OOK format vastly outperforms the 2-PAM and 4-PAM formats in terms of tolerance to transmission penalties. Nevertheless, 4-PAM format is still an effective way to double the data rate in access networks. This study provides vital performance awareness information needed for capacity upgrade in next-generation optical access networks.

Keywords: OOK, Pulse amplitude modulation (PAM), VCSEL, optical access network

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. Timothy Gibbon
Tim.Gibbon@nmmu.ac.za
Nelson Mandela Metropolitan University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 15 / **321**

Lanthanum phosphovanadate phosphors: Effect of terbium concentration

Author: Teboho Moloi[1]

Co-authors: Kamohelo George Tshabalala [2]; Odireleng Ntwaeaborwa [3]; Selepe Joel Motloung [2]

[1] *University of the Free Sate*

[2] *University of the Free State*

[3] *University of the Witwatersrand*

Terbium activated lanthanum phosphovanadate phosphor powders were synthesized using solution combustion method. The concentration of terbium was varied from 1 – 10 mol %. The X-ray diffraction (XRD) indicated that all different concentrations exhibit the same trend, implying that dopant concentration on host did not affect crystal structure. Scanning electron microscopy (SEM) images show that the prepared phosphors consisted of agglomeration of particles of different shapes but when samples are put under high temperatures, clear shapes appeared. Energy dispersive x-ray spectroscopy (EDS) confirmed the presence of all main elements forming the desired compound. The band gap energies were estimated from Kubelka-Munk plot and they were found to range from 3.1 to 4.3 eV. The photoluminescence (PL) spectra show four emission peaks corresponding to transitions of terbium. The optimum concentration for this work was found to be 7 mol %. These materials are evaluated as possible candidates to improve the power conversion efficiency of dye sensitized solar cells.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Tshabalala KG
tshabalalakg@ufs.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Physics of Condensed Matter and Materials 1 / **322**

Effects of growth time on structural and optical properties of ZnO nanorods on Ga-doped ZnO seed layer for dye-sensitized solar cells photoanode

Author: Jatani Ungula[1]

Co-authors: Francis B Dejene [1]; Hendrik C Swart [1]

[1] *University of the Free State*

ZnO nanorods (ZRs) were synthesized on glass substrates coated with Ga-doped ZnO (GZO) seed layer by a two-step chemical bath deposition technique (CBD) in an equimolar (50 mM) aqueous solution of zinc nitrate hexahydrate and hexamethylenetetramine at 90 ℃. The GZO NPs seeding was done to lower the thermodynamic barrier by providing nucleation sites to improve the aspect ratios and optical properties and ensure uniformity of ZRs [1]. The effect of CBD growth times 30, 60, 90, 120, 180, 240 and 320 min on the morphology, luminescence and optical properties of ZRs were investigated. The XRD analysis revealed that the as-grown ZRs have a crystalline hexagonal wurtzite structure and was preferentially oriented along the c-axis. The highest intensity of the (002) peak was observed on the 120 min among the growth durations studied. The SEM micrographs showed that both the length and aspect ratio of the ZRs increased as the growth time increases up to 120 min, then reduced at higher growth times. The photoluminescence measurement spectra depict an enhanced intensity ratio of the UV to visible emissions for ZRs grown on GZO seed layer indicative of high optical quality. The UV-Vis analysis showed that the transmittance of the films was above 80 % and the band gap varied from 3.20 to 3.3 eV with the increase in growth time.The highly transparent film composed of well-aligned ZRs with perfect crystallization produced at the growth time of 120 min can be used as a possible photoanode component in dye-sensitized solar cell.

Reference:
[1] H. K. Lee, M. S. Kim, J. S. Yu, Nanotechnology 22, 445602, 2011.

Summary:

ZnO nanorods (ZRs) were synthesized on glass substrates coated with Ga-doped ZnO seed layer by a two-step chemical bath deposition technique (CBD) in an equimolar (50 mM) aqueous solution of zinc nitrate hexahydrate and hexamethylenetetramine at 90 ℃.The effect of CBD growth times 30, 60, 90, 120, 180, 240 and 320 min on the morphology, luminescence and optical properties of ZRs were investigated.The highly transparent film composed of well-aligned ZRs with perfect crystallization produced at the growth time of 120 min can be used as a possible photoanode component in dye-sensitized solar cell.

**Apply to be
 considered for a student
   award (Yes / No)?**:

YES

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof Francis B Dejene
Dejenebf@ufs.ac.za
University of the Free State

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

YES

Poster Session 2 - Board: 16 / **323**

Synthesis and Characterization of Cadmium Selenide Quantum Dots

Author: Sinovuyo Makinana[1]

Co-authors: Edson Meyer [1]; Raymond Taziwa [1]

[1] *1Fort Hare Institute of Technology (FHIT), University of Fort Hare, Private Bag X1314, Alice, 5700, Republic of South Africa. 2Chemistry department, University of Fort Hare, Private Bag X1314, Alice, 5700, Republic of South Africa*

Corresponding Author: sinovuyomakinana@gmail.com

CdSe quantum dots (QDs) with different particle sizes were successfully synthesized using the hot-injection method. The CdSe QDS were synthesized by reacting cadmium acetate dihydrate [Cd (CH_3COO) $2{\cdot}2H_2O$] and selenium (Se) powder in the presence of 2-mercaptoethanol as the capping agent. CdSe QDs of different crystallite sizes were prepared at different reaction temperatures of 150°C to 175°C, 200°C, 225°C, 250°C, 275°C and 300°C.The morphological, structural and optical properties of the as synthesized CdSe QDs were evaluated using SEM, XRD, HRTEM, and UV-Vis spectroscopy. From the UV-Vis, it was found that the crystallite size of CdSe QDs increases with the increase in reaction temperatures. The Kippeny method was used to calculate the crystallite size of CdSe QDs and it was found to be in the range of 0.82 – 2.46 nm. Furthermore, the data analysis has revealed that CdSe QDs crystallite size is dependent upon the reaction temperature.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof. Edson Meyer
EMeyer@ufh.ac.za
Fort Hare Institute of Technology
University of Fort Hare

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 42 / **324**

Comparison of Ionospheric Scintillation recorded by the Gough Island stationary receiver and by a receiver on the SA Agulhas II Polar Research Vessel

Author: Annelie Vermeulen[1]

Co-authors: Peter Martinez [2]; Pierre Cilliers [3]

[1] *UCT SpaceLab*

[2] *UCT*

[3] *SANSA Space Science*

Corresponding Author: ani@entropy.co.za

This paper reports the novel use of a dual-frequency GPS Ionospheric Scintillation and Total Electron Content Monitor (GISTM), located on the polar research vessel SA Agulhas II, to identify instances of ionospheric scintillation in the South Atlantic Magnetic Anomaly (SAMA). The SAMA is a region in the South Atlantic Ocean where the Earth's magnetic field is weakest at comparable latitudes resulting in an increased likelihood of precipitation of high energy particles into the ionosphere during geomagnetic storms.

Ionospheric scintillations are rapid fluctuations in the phase and amplitude of trans-ionospheric radio signals resulting from electron density variations along the signal ray path. In this study, the radio signals between Global Positioning System (GPS) satellites and terrestrial receivers are specifically used to quantify these fluctuations.

Traditional scintillation measurements are done using dedicated dual-frequency GPS receivers at fixed terrestrial locations. The SAMA lies predominantly over the ocean and significant portions are beyond the reach of land-based instruments. The GISTM installed on board the SA Agulhas II in 2012 has enabled for the first time the terrestrial measurement of ionospheric scintillation over an extended part of the SAMA. The South African National Space Agency (SANSA) also operates a fixed GISTM on Gough Island, located at 40&deg 20' 58.90" S, 9&deg 52' 49.35" W, which falls within the SAMA.

In this project, the amplitude scintillation index (S₄) and phase scintillation index (&sigma<sub>&Phi</su
from 50 Hz L1 signals recorded on board the SA Agulhas II and on Gough Island during the period 15 - 28 September 2014 are analysed and compared for the first time. Position and movement data, as well as Total Electron Content (TEC), number of satellites, and satellite lock-time are used in this study.

It is shown that the movement of the ship introduces significant noise in the phase scintillation data. The noise levels are related to the motion of the ship. Ship-to-Shore comparisons are confined to the period in which the ship is less than 100 km from Gough Island. Geomagnetic storm conditions for the period in question are also investigated to determine whether a significant solar event might have had an influence on the levels of scintillation.

Summary:

A comparison study of ionospheric scintillation recorded by the Gough Island stationary receiver and by a receiver on the SA Agulhas II polar research vessel, for the period 15-28 September 2014 during which the instruments were located less than 100 km apart.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Dr Pierre Cilliers
pjcilliers@sansa.org.za
SANSA Space Science & UCT SpaceLab

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Applied Physics / **325**

Demand and supply site approaches for energy conversion from macadamia nut shells waste and castor cake.

Author: Antoine-Floribert MULABA-BAFUBIANDI[1]

Co-authors: Mmatseleng Getrude ntobeng [2]; Tiny-Henriette Dania [3]

[1] *School of Mining, Metallurgy and Chemical Engineering, University of Johannesburg*

[2] *University of Johannesburg*

[3] *Mineral Processing and Technology Research Centre*

Corresponding Author: amulaba@uj.ac.za

The increasing macadamia production in the Southern Africa and the need to leverage on existing indigenous plants like castor seeds for medicinal applications have led to the production on high amount of processing and agricultural wastes. A significant increase in demand for alternate energy sources (renewable electricity, biofuel and gas etc..) has stressed on the negative environmental impact caused by the conventional fossil fuel sources (coal, petroleum, and natural gas). Observed negative impacts on the environment of producing energy from waste should be minimised for an optimum environmental preservation. Demand site approach or/and supply site approach would be the employed strategy tools to ensure an optimum balance between producing the required energy and minimising the unwanted waste. Collected data from secondary sources and conducted experiment work will be discussed while the minimisation of the generated waste as the maximisation of energy produced will be ensured.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Antoine F. Mulaba-Bafubiandi
amulaba@uj.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Full

Applied Physics / 326

Experimental and Numerical Heat Transfer Analysis of Cavity Absorber and The Application of Different Optically Active Layer for Parabolic Solar Trough Concentrator.

Author: Khaled Mohamad[1]

Co-author: Philippe Ferrer [2]

[1] *PhD student*

[2] *Doctor (Main Supervisor)*

The solar parabolic trough collectors (PTC) are the earliest and most widely accepted Solar concentration style. It is the most mature technology, has been intensively researched and its cost gradually reduced. In addition, PTC have been put into commercial operations in many countries. The research in this technology is moving towards increasing the efficiency of the system, specifically raising the temperature of the working fluids by minimizing the energy losses. The efficiency of the whole system depends on the most complex part of it, which is the receiver unit. This work aims to design the receiver unit in a way that minimizes the energy losses and raises the temperature of the working fluid. The receiver unit incorporates the application of different optically active layers in tandem with the application of a cavity absorber. The cavity geometry will enable efficient capturing of incoming concentrated solar radiation via multiple internal reflection. This study entails numerical heat analysis, which is used to simulate the temperature profile of the receiver unit and study the optical properties of different designs. In addition, this idea has been tested experimentally through a prototype parabolic solar trough. The results are promising from both the experimental and numerical side.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Name: Dr. Philippe Ferrer
email: Philippe.Ferrer@wits.ac.za
Institution: Witwatersrand University.

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 17 / **327**

Interaction of tungsten (W) film with glassy carbon

Author: Audu Innocent[1]

Co-authors: Eric Njoroge [1]; Johan Malherbe [1]; Thulani Hlatshwayo [1]

[1] *University of Pretoria*

Thin film of tungsten (W) was deposited on glassy carbon (GC) substrate using a magnetron sputtering system. The as-deposited samples were annealed under vacuum at temperatures ranging from 600 to 1000 oC for 1hr. The interaction in the interface of W and GC was investigated Rutherford backscattering spectroscopy (RBS) and scanning electron microscopy (SEM). RUMP software was used to simulate the RBS spectra. The thickness of W thin film deposited, atomic composition of deposited layer and the reaction zone (RZ) were deduced from the RUMP results. W-GC interaction became pronounced at annealing temperature from 800 oC and increased progressively up to the highest annealing temperature. The surface morphology of the diffusion couples were examined on SEM. The as-deposited sample possessed a smooth uniform layer of W film while the annealed samples showed a progressive increase in grain size with increased annealing temperature. The atomic composition profile reveals the detailed extent of intermixing and diffusion of the atomic species at the elevated temperatures.

Keywords: tungsten, glassy carbon, interaction, annealing, RBS, RUMP, SEM

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. J.B. Malherbe, Johan.Malherbe@up.ac.za
University of Pretoria, South Africa.

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Physics Education / **328**

Physics as background foundation for process engineers and analytical scientists

Author: Antoine-Floribert MULABA-BAFUBIANDI[1]

[1] *School of Mining, Metallurgy and Chemical Engineering, University of Johannesburg*

Corresponding Author: amulaba@uj.ac.za

Process engineers and analytical scientists are introduced to logical system thinking,spectroscopy, diffractometry, wet analysis etc… where dependent and independent variables are assessed. Fourier Transform Infrared spectroscopy utilises the Michelson interferometry while X-Rays diffraction and fluorescence exploit the Bragg's law. Laplace transforms are main tools utilised while solving complex process problems. This paper raises the needs of a sound for physics knowledge and background for the understanding of the phenomenon faced with in the use of analytical pieces of equipment and to facilitate the interpretation of the collected data. Case studies experienced during 39 years of teaching experience will be discussed.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Self

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Full

Poster Session 2 - Board: 18 / **329**

STRUCTURAL AND RAMAN SPECTROSCOPIC CHARACTERIZATION OF C-TIO2 NANOTUBES SYNTHESIZED BY TEMPLATE-ASSISTED SOL-GEL TECHNIQUE.

Authors: David Katwire[1]; Edson Meyer[1]; Nwabisa Takata[2]; Taziwa Raymond[3]

Co-author: CLIVE OLIPHANT [4]

[1] *University of Fort Hare*

[2] *Fort Hare Institute of Technology, University of Fort Hare, National Metrology Institute of South Africa*

[3] *University of Fort hare*

[4] *NMISA*

Corresponding Author: lolotakata@gmail.com

Un-doped and carbon-doped titanium dioxide nanotubes (C-TNTs) were synthesized using a template-assisted sol-gel technique employing titanium tetra butoxide precursor and oxalic acid as the dopant. SEM, XRD, FTIR and Confocal Raman spectroscopy (CRS) was used to evaluate the morphological and structural properties of the as-synthesized TNTs. SEM analysis has revealed the presence of closely-packed TNTs, with a modal external tube diameter of 150, 170, 210,190 and 210 nm for the un-doped TNTs, 9mM C-TNTs, 27 mM C-TNTs, 45 mM C-TNTs and 75 mM C-TNTs respectively. SEM analysis has also shown that the TNTs become loosely-packed with increasing dopant concentration. SEM-EDX spectra have revealed the presence of Ti peaks at 0.45 and 4.9 KeV corresponding to $K\alpha 1$ and $K\beta 1$ emission line respectively. Oxygen exhibits a signal at 0.5 keV corresponding to $K\alpha 1$ emission line. The occurrence of these peaks in the EDX spectra endorses the existence of Ti and O

atoms in the prepared titanium dioxide nanotubes. FTIR spectroscopy has revealed the presence of vibrational modes at 580-660 cm-1 indicating the presence of Ti-O bonds and additional vibration modes at 2324 cm-1 resulting from C-O stretching in the carbon doped samples XRD analysis has revealed the presence of a mixed Anatase-Brookite phase with diffraction peaks 2θ angles of 25.49°, 38.11°, 40.60° 48.14 °, 54.58°, 63.00°, 70.11° and 75.66°. Additionally, XRD analysis has revealed elongation of lattice parameter “c” from 9.143 to 9.830 Å with increase carbon concentration. Lattice expansion indicates the possibility of carbon substituting oxygen sites. CRS large area scan in the XY direction has revealed the presence of Raman active modes at 153.19 cm-1, 205.62 cm-1,328.33 cm-1, 404.55 cm-1, 523.26 cm-1, 523.26 cm-1 and 648.69 cm-1 belonging to a mixed Anatase-Brookite phase. CRS depth profiling in the XZ direction has also validated the presence of a mixed Anatase-Brookite phase with Raman active modes 153.19, 208.87, 404.55, 523.26 and 648.55 cm-1.

**Apply to be
 considered for a student
   award (Yes / No)?**:

YES

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Edson Meyer
emeyer@ufh.ac.za
Fort Hare Institute of Technology

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 75 / **330**

Effect of Sm doping on the structural and optical properties of ZnO nanorods grown by chemical bath deposition

Author: MUSTAFA AHMED[1]

Co-authors: Jackie Nel [2]; Walter Meyer [3]

[1] *MAM AHMED*

[2] *JM Nel*

[3] *WE Meyer*

Recently, one-dimensional (1D) semiconductor such as nanowires, nanobelts, nanorods and nanotubes have attracted much interest due to their unique properties and potential use in a wide range of device such as single electron transistor [1], photodiodes [2] and sensing applications [3]. 1D structures of ZnO with a wide band gap (3.37 eV) and large exciton energy (60 meV) at room temperature have been studied intensively [4]. The electrical and optical properties of ZnO can be enhanced by doping it with some cations. For example, rare-earth (RE) elements are usually used as a cations in some of the host materials, due to their high fluorescence efficiencies [5]. Here, we report on the synthesis and characterization of RE samarium (Sm) doped ZnO nanorods with doping concentration ranging from 0 to 8 at.%. These nanorods were synthesized and deposited on an indium tin oxide (ITO) substrates using chemical bath deposition method at low temperature (85 - 90) ° C. The as-synthesised ZnO and Sm doped ZnO were characterized at room temperature using X-ray diraction spectroscopy (XRD) and scanning electron microscopy (SEM). Results from XRD pattern and SEM revealed that the ZnO nanords have the wurtzite crystal structure. Furthermore, results from photoluminescence spectroscopy, UV-visible spectroscopy and Raman spectroscopy as well as X-ray photoelectron spectroscopy will be described in more detail.

References
[1] F Vetrone J B and Capobianco J A 2005 Adv. Mater 16 14
[2] Wang R X Yan Z H L W J H B X W Q P and Angew Y D 2005 Chem. Int. Ed 44 6054
[3] LF Dong Z C and Zhang Z 1997 Nano. Struct. Mater 8 815
[4] G C Yi C W and Park W 2005 Semicond. Sci. Technol. 20 22
[5] D K Sharma K S and Kumar V 2016 J. Mater. Sci: MaterElectron 27 10330

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Jackie Nel
Jackie.Nel@up.ac.za
University of Pretoria

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Astrophysics / **331**

Latest Results from the XENON1T Experiment

Author: Jacques Pienaar[1]

[1] *Purdue University*

Corresponding Author: jpienaa@purdue.edu

XENON1T is a two-phase xenon TPC for the direct detection of dark matter. The target mass is 2 tons of liquid xenon. The detector was commissioned in the middle of 2016, and completed its first science run in January 2017. During the science run the detector has achieved the world's lowest background among comparable experiments. This talk will present the detector performance, calibration, and background studies which are paving the way towards the world's most sensitive dark matter search, and present the results of the first science run.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof Rafael Lang (rafael@purdue.edu)

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

no

Photonics / **332**

The Wigner distribution function in characterising general optical fields of varying coherence

Author: Prince Mredlana[1]

Co-authors: Andrew Forbes [2]; Cosmas Mafusire [3]; Darryl Naidoo [4]; Nyameko Lisa [5]

[1] *Student*

[2] *CSIR*

[3] *University of Pretoria*

[4] *Council for Scientific and Industrial Research*

[5] *CSIR National Laser Centre*

The coherence of optical fields is a defining factor in how they are represented and characterised, in this work we employ the Wigner Distribution Function (WDF) for a generalized optical field characterisation method. We characterize a Gaussian-Schell model partially coherent beam by determining the beam width, divergence, curvature and beam quality factor of the pure field from the mutual correlation function and its corresponding WDF. The beam is digitally encoded using an SLM. The WDF is a space-frequency representation and in the spatial domain, we find comparable accuracy between the parameters obtained using the pure optical field and the WDF.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Msc

**Main supervisor (name and email)
and his / her institution**:

Darryl Naidoo, dnaidoo3@csir.co.za.

CSIR National Laser Centre

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Space Science / 333

Structure of magnetic turbulence at 1 AU

Author: Renier Burger[1]

[1] *North-West University*

Corresponding Author: adri.burger@nwu.ac.za

Analysis of turbulence data

Summary:

Ab initio cosmic-ray modulation models require turbulence spectra as input for the diffusion tensor. If one assumes a composite slab/2D structure for the turbulence, the so-called slab ratio - which is the ratio of the energy density in the slab spectrum compared with the total energy density - is required. Bieber et al. (1996, JGR, 101) describe two methods for calculating this ratio; Saur and Bieber (1999, JGR, 104) add a third method. After a brief introduction to the partial variance technique, we apply it in a preliminary study of the slab ratio for both the inertial- and the energy range of magnetic turbulence observed at

1 AU, using ACE data for 1998 to 2015. We use only the so-called ratio test of Bieber et al., which is based on fitting data to the ratio of the two theoretical spectrum components perpendicular to the mean magnetic field, denoted by Pyy/Pxx. Here the y-direction is perpendicular to the plane containing the mean magnetic field and the radial direction, and the x-direction is in that plane. Saur and Bieber tested both the radial and the mean field direction as candidate symmetry axes for turbulence in the energy range; here we test this only for the slab component but for both the energy- and the inertial range. For the inertial range we find an average slab fraction of 0.29 for the whole data set, which is in good agreement with values reported in other studies using the ratio test. Our analysis suggests that the slab turbulence in this high-frequency regime is symmetric with respect to the mean magnetic field, and not the radial direction. However, for the energy range, we find that at low frequencies the radial direction is the symmetry axis for the slab turbulence, in agreement with Saur and Bieber. We find an average slab fraction of 0.31 for the energy range, which is smaller than the value of 0.36 reported by these authors. We cannot as yet rule out that the slab fraction is the same in these two energy regimes when error margins are taken into account. We also show that the slab fraction can vary by as much as a factor of four during the course of a solar activity cycle. This implies that the parallel mean free path could vary by the same factor. In non-linear theories for perpendicular diffusion, this would also affect the perpendicular mean free path, and most probably also the drift scale. The consequences of a slab fraction that is different for the energy- and for the inertial range, and that varies with solar activity, have yet to be studied in ab initio modulation models.

This work is based on research supported by South African National Research Foundation Grants 80824, 93592 and 96478.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Theoretical and Computational Physics 1 / 334

Study of solitons in plasmas based on Vlasov simulation approach

Author: Seyyed Mehdi Hosseini Jenab[1]

Co-author: Felix Spanier [2]

[1] *North-West University*

[2] *NWU*

Corresponding Author: mehdi.jenab@yahoo.com

Solitons, as the first phenomena discovered in nonlinear physics, has played a decisive role in the study of nonlinear structures. They show two interesting and distinctive properties, including propagation without alteration in their features and stability against mutual collisions. In plasma physics ion-acoustic solitons (IASs) has been the forefront of the nonlinear plasma research field. Here, we are presenting the results of our studies on IASs based on a fully kinetic approach, i.e. utilizing Poisson-Vlasov set of equations to follow the temporal evolution of the plasma species, namely electrons and ions.

Our studies have proven that IASs continue to show their two major properties even when kinetic effects, mainly electron trapping, are present. Furthermore, our study has investigated the process of mutual collisions of IASs on the kinetic level by showing the temporal evolution of distribution

functions, for the first time. These resulted in new understanding of solitons behavior during collision. Although on fluid level, the collision process is independent of the relative velocity of solitons, relative velocity plays an important role in the final combination of the trapped population on the kinetic level. For over-taking collisions, the two solitons exchange certain amount of their trapped populations. However, for head-on collisions, the two solitons trap some portion of each others trapped population. Moreover, if the relative-velocity is small enough, solitons repel each other due to the overall charges they carry because of their trapped electrons.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

y

Poster Session 2 - Board: 19 / **335**

Effects of irradiation energy and fluence on the optical absorbance of silver implanted amorphous carbon thin films

Author: Abdulsalam Ismaila[1]

Co-authors: Franscious Cummings [2]; Shunmugan, R Naidoo [3]

[1] *Wits*

[2] *University of the Western Cape*

[3] *DST-NRF Centre of Excellence in Strong Materials,University of the Witwatersrand, Wits*

Corresponding Author: abdu.ismaila@gmail.com

An initial investigation of the optical properties of silver doped amorphous carbon films is presented in this study. The effects of alternate variations of irradiation energies and fluences in relation to the surface plasmon resonance (SPR) were studied. The study exhibits that the shifts in energy and fluences suggested a change in the overall optical absorbance and consequently on the plasmonic properties of the thin films.

Summary:

The study describes how the working conditions in an ion implantation procedure influence the optical absorbance of carbon thin films.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Professor S. R. Naidoo
mervin.naidoo@wits.ac.za
School of Physics, University of the Witwatersrand, Johannesburg, South Africa.

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Applied Physics / **336**

Monitoring of grid-integrated photovoltaic systems comprising different solar cell technology type

Author: Akhona Yaso[1]

Co-authors: Ernest van Dyk [1]; Frederik Vorster [1]; Ross Schultz [1]

[1] *NMMU*

Corresponding Author: yasoakhona@gmail.com

This paper addresses the monitoring of four Photovoltaic (PV) systems that comprise different technologies and are grid-connected. The main outcome of the study is to obtain an insight into the power generation and performance of PV systems in an embedded generation environment. This study is based on operational systems at the Outdoor Research Facility (ORF) on the NMMU South Campus. These are AC-coupled systems that form part of the embedded generation reference network established at NMMU. The purpose of the network is to monitor all PV systems aspects operating under the same environmental conditions. The four systems analysed are; a) 3.2 kWp polycrystalline Si, b) 1.36 kWp copper indium diselenide (CIS), c) 1.41 kWp monocrystalline Si and, d) 1.32 kWp Cadmium telluride (CdTe). The custom-designed and constructed data logging systems measure AC and DC parameters to evaluate the performance parameters of each PV array and inverter. The measured data facilitates analysis of performance and energy yield

Summary:

This paper will discuss the data logger design, algorithms used to collect and process data, and give a detailed analysis of preliminary data; such as PV performance, performance ratio, final yield, and the reference yield for each PV system.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Msc

**Main supervisor (name and email)
and his / her institution**:

Prof van Dyk, Ernest
Ernest.vanDyk@nmmu.ac.za
NMMU

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 76 / **337**

A semi-classical and quantum mechanical analysis of Four-Wave-Mixing in an ensemble of Rubidium atoms

Author: Meena Patel[1]

Co-authors: Gerhard de Jager [2]; Kessie Govender [1]; Mpiana Florimond [3]

[1] *Cape Peninsula University of Technology*

[2] *UCT*

[3] *UKZN*

Corresponding Author: govenderk@cput.ac.za

Entangled photons are an essential ingredient in quantum information and quantum computing systems. We are currently investigating entangled photon generation via four-wave-mixing using a diamond configuration formed by four levels in Rubidium. Two pump laser beams of different wavelengths drive the atoms from a ground state |1> to an excited state |3> via an intermediate state |2>. The atoms then return to the ground state via another intermediate state |4>. 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.

As a precursor to the experimental work we perform a theoretical and computational analysis using, initially, a semi-classical model where the atom is quantized, while the photons are treated classically. Using perturbation analysis we solve for the higher order density matrix elements, from which we determine the higher order atomic polarization. This is then used in Maxwell's equations to determine the intensities of the idler and signal photons. Results of the intensities of the additional photons and the population of the various levels, as a function of detuning of the pump lasers, are presented. The analysis is then extended to include a full quantum mechanical analysis, where the photons are described by the annihilation and creation operators.

Summary:

A semi-classical and quantum mechanical analysis of Four-Wave-Mixing in an ensemble of Rubidium atoms.

**Apply to be
 considered for a student
   award (Yes / No)?**:

NO

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

NO

Photonics / **338**

A New Simplified Spatial Resolution Criterion to Obtain the MTF Curve From Edge Analysis in the Real Space

Author: Mabuti Jacob Radebe Radebe[1]

Co-authors: Anders Kaestner [2]; ELIAS SIDERAS-HADDAD [3]

[1] *Necsa*

[2] *Paul Scherrer Institut*

[3] *University of the Witwatersrand*

Corresponding Author: mabuti.radebe@necsa.co.za

Digital neutron imaging (radiography and tomography) is a powerful non-destructive analytical tool and has demonstrated its importance in industrial and research applications world-wide. The standardization process, to certify digital thermal neutron imaging as a standard practice in industry, entails standardized performance characterization methods. Spatial resolution is one of the key performance indicators of the digital neutron imaging instrument. Knowing the spatial resolution of an imaging system is essential for the accuracy of dimensional measurements.

There are standards for digital imaging like the ISO 12233: 2014 on spatial resolution and spatial frequency responses, which is also applicable to digital neutron radiography provided adjustment of some limiting criteria is performed. This standard applies edge analysis through the modulation transfer function (MTF) method. The modulation transfer function analysis is conducted in the Fourier domain, which some operators find cumbersome and in addition it does not provide information about the resolution sharpness of the system. The current work provides a simpler and unambiguous edge analysis method conducted in the same domain as the image information. It establishes a criterion for edge analysis in the spatial domain and compares the results to MTF according to ISO 12233: 2014. The use of Full Width at Half Maximum (FWHM) on the line spread function (LSF) is discouraged and the limitation of the 10% - 90% on the edge spread function (ESF) to only estimate resolution limit at 10% MTF is overcome through the criterion established in this work. This criterion produces a full MTF curve from 0% to 100% MTF values from the edge analysis in the same domain as the image.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. Elias Sideras-Haddad. Elias.Sideras-Haddad@wits.ac.za. University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Applied Physics / 339

Establishment of Methods for Spatial Resolution Assessment in Digital Neutron Radiography and Tomography Facilities

Author: Mabuti Jacob Radebe Radebe[1]

Co-authors: Anders Kaestner [2]; ELIAS SIDERAS-HADDAD [3]

[1] *Necsa*

[2] *Paul Scherrer Institut*

[3] *University of the Witwatersrand*

Corresponding Author: mabuti.radebe@necsa.co.za

Digital neutron radiography and tomography analytic techniques have found applications ranging from quality assurance to research because of the unique nature of interaction of neutron with materials. These radiation based imaging analytical techniques have gained acceptance because they are non-destructive and their output are radiographs or tomograms in real space. Neutron Radiography facilities provide results which lead to quality related decision making or diagnosis of an abnormality – therefore it is necessary to qualify the performance of the setup. Spatial resolution has been identified as one of the important key factors for characterization of the performance of radiography and tomography setups. It can be assessed using discrete and continuous test objects, as well as using statistical correlation methods.

This contribution assesses and adapts methods for evaluation of the spatial resolution of radiography and tomography facilities through the design of test objects, experimental protocol, data post processing and analysis procedures. Spatial resolution characterization methods which are assessed

and adapted are Discrete Spatial Resolution Method (SSRM), Modulation Transfer Function (MTF), Fourier Ring correlation (FRC) and Spectral Signal-to-Noise Ratio (SSNR).

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. Elias Sideras-Haddad. Elias.Sideras-Haddad@wits.ac.za. University of the Witwatersrand.

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 20 / **340**

Stability of transition metal nitrogen and boron defect complexes in diamond

Author: Brian Nyandoro[1]

Co-authors: Enrico Lombardi [1]; Evans Benecha [1]

[1] *University of South Africa*

Corresponding Author: ebenecha@gmail.com

Energetic stability of transition metal ions in diamond holds the prospect of achieving a diamond based dilute magnetic semiconductor, which, in addition to diamond's extreme properties may successfully be considered for spintronic device applications. However, the high formation energy of transition metal ions in diamond leads to low concentration of dopant ions, which has a detrimental impact on the achievable Curie temperature. We investigate the stability of 3d transition metal defect complexes of nitrogen (TM-N) and boron (TM-B) in diamond using ab initio GGA+U Density Functional Theory electronic structure calculations. Specifically we consider the formation energies of these complexes for various charge states and lattice sites, in comparison with that of isolated single transition metal defects. We find that the formation of the TM-N, TM-N complexes is significantly lower by 4-4.5 eV, compared to that of single transition metals in diamond, demonstrating that co-doping with shallow donors or acceptors will considerably enhance the concentration and stability of transition metals in diamond.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 21 / **341**

Growth & characterisation of diamond films in magnetron sputtering by spin coating

Author: NP Chonco[1]

Co-authors: Bonex Mwakikunga [2]; Muzi Ndwandwe [1]

[1] *University of Zululand*

[2] *CSIR*

Corresponding Author: chonconelisiwe@gmail.com

Abstract. There is a growing necessity for materials to be used under extreme conditions. Diamond is well known as an excellent material which has high hardness, good thermal conductivity and chemical resistance. In this study, we tried to grow diamond films on p-type silicon substrate and also on glass substrates by using the method of spin coating. Diamond films were grown by direct current (DC) unbalanced magnetron sputtering. The physical and electrical properties of diamond films were investigated by Scanning electron microscopy (SEM),thin films X-ray diffraction (XRD) and Rutherford backscattering (RBS). The pressure was maintained at 3x10-3 Torr while bleeding C2H2 into the chamber.
Keywords: Diamond films, spin coating, DC magnetron sputtering & CVD method, surface morphology

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Muzi Ndwandwe
NdwandweO@unizulu.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 77 / **342**

Resonant Ionisation Spectroscopy with Time-of-Flight mass detection

Author: Frederick Waso[1]

Co-authors: Anton du Plessis [1]; Christine Steenkamp [2]; Robert Bark [3]

[1] *Stellenbosch University*

[2] *University of Stellenbosch*

[3] *iThemba LABS*

Corresponding Author: fjw@live.co.za

In this project we will develop a laboratory setup to do Resonant Ionisation Spectroscopy (RIS) of the non-radioactive isotopes of Tin (Sn). Using the RIS method a target element can be ionised and subsequently extracted by electric fields. This method is a critical step in the production of Radioactive Ion Beams (RIBs) used in nuclear physics research, for example at CERN ISOLDE, or for medical applications, for example at CERN MEDICIS.
The focus of this presentation is on ion detection. An experimental setup will be developed for

laser ionisation and spectroscopy in a gas and a time-of-flight mass spectrometer (ToF-MS) will be commissioned and tested for ion detection. ToF-MS will be used to identify ionised species. The ToF-MS will also be used to find an effective ionisation scheme for Sn that enhances selectivity and ion production. An atomic vapour of Sn is required and laser ablation using a frequency doubled Nd:YAG laser has been chosen as the desired method to vaporise the element. The Sn vapour will then be introduced into the ToF-MS as a supersonic jet.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Dr Christine Steenkamp
cmsteen@sun.ac.za
Stellenbosch University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Theoretical and Computational Physics 1 / 343

Bayesian parameter estimation and model comparison for discrete data spectra

Author: Li Wang[1]

Co-author: Hans Eggers [1]

[1] *Stellenbosch University*

Discrete random variables appear in many scientific fields. In physics, laboratory experiments often involve discrete counts of particles or photons e.g. in nuclear physics, laser physics, and experimental high energy physics. In other cases, data is compressed into integer form. Such counts of some quantity are measured in 'channels' such as angle, wavelength, multiplicity etc. Data will initially be generated by simulation to test the analytical framework and numerical strategies in the Bayesian theorem. At an advanced stage, application to laboratory spectra becomes feasible with corresponding physics insights, advanced techniques such as nested sampling is included.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof.H.C.Eggers
eggers@physics.sun.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

344

STUDENT GENDER PERFORMANCE IN PHYSICS PRACTICALS

Author: Maria Vivien Visaya[1]

Co-author: Tasneem Limbada [1]

[1] *University of Johannesburg*

Corresponding Author: mvvisaya@uj.ac.za

An analysis of longitudinal student Physics practicals data over a time period of three semesters is conducted. In particular, we study the association between gender of students and their overall mark (OVM) and their Physics practicals marks in Mechanics, Thermodynamics, Optics, and Electricity. Together with gender, all variables are binarized, i.e. distinction mark (≥75) =1 and zero otherwise. To visualize performance of students, the qualitative method of plotting a two-dimensional orbit is used to represent binary multivariate longitudinal data of each student. Analysis of orbits reveals information of patterns in the data. This study gives a good indication of which fields of Physics females perform well in and which fields the male students are stronger in (equivalently where gender struggled in various practicals). In particular, male students tend not to get distinctions in both Mechanics and OVM, but that females tend to get distinctions in OVM. We have also observed that students' 0/1 marks is most stable (i.e. least changing) in Optics and OVM. A comparison to the GEE statistical model tells us that visual results present initial insights to help and complement statistical data analysis.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Theoretical and Computational Physics 1 / 345

Entanglement and Gravity

Author: Jonathan Hartman[1]

Co-authors: Christian Engelbrecht [1]; Francesco Petruccione [2]; Simon Connell [1]

[1] *University of Johannesburg*

[2] *UKZN*

Corresponding Author: shconnell@uj.ac.za

Entanglement in Quantum Mechanics leads to a non-local correlation between two particles. The question arises as to whether changes in local gravity, or the equivalently the local background metric affects the correlation. There are several approaches to answering this question. This work discusses the treatment of the background gravity by using the equivalence principle to map it to a local acceleration. On can then use the concept of Rindler frames to treat the problem in the context of special relativity for uniform acceleration. A Thomas precession is shown to manifest for the particle spins. The effect of this on the maximal violation of a Bell inequality has been evaluated for a range of scenarios for systems of entangled particle pairs.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

SH Connell
University of Johannesburg

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Applied Physics / **347**

The MinPET diamond discovery technique

Author: Thendo Nemakhavhani[1]

Co-authors: Doomnull Attah Unwuchola [2]; Martin Cook [1]; Richard Andrew [3]; Simon Connell [1]

[1] *University of Johannesburg*

[2] *University of Johannnesburg*

[3] *University of Pretoria*

Corresponding Author: shconnell@uj.ac.za

MinPET is a technology for diamond discovery in rock, specifically, the online, high throughput, quantitative, 3D imaging of local carbon concentration distributions in kimberlite. In the MinPET process, a high-energy photon beam of some tens of MeV irradiates a kimberlite rock stream, exciting the Giant Dipole Resonance. This transmutes especially some of the light stable isotopes within the kimberlite to become transient positron emitters, or Positron Emission Tomography (PET) isotopes. PET imaging of the rock is performed in an online run-of-mine scenario after a hold hopper, which delays detection for 20 minutes. After this time, 11C is the dominant PET isotope. All non-diamond sources of carbon have a much lower carbon concentration than diamond, or they are diluted and finely dispersed within the kimberlite. Diamond is therefore evidenced by reconstructing the 3D quantitative carbon density distribution map. This talk reviews the current status of the R&D towards a Mine Test Unit.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

SH Connell
University of Johannesburg

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Physics of Condensed Matter and Materials 1 / 349

Structural evolution and ion diffusion of TiO₂ nanosheet at different temperatures for anode material Li-ion batteries.

Author: Blessing N Rikhotso[1]

Co-author: malili Matshaba [2]

[1] *University of Limpopo*

[2] *university of LImpopo*

The structural evolution of TiO₂ nano-sheet is investigated by molecular dynamics code upon heating up to crystallization. The structural rearrangements during cooling and heating process are analysed as a function of temperature, focusing on shift of the peaks in X-ray diffraction and radial distribution function. Diffusion Coefficients of Li are measured to be increasing with an increase in temperature. The structure of TiO₂ nano-sheet was maintained at elevated temperatures as observed on their micro-structure and XRD's. Thus rendering suitable anode material for Li – ion batteries since it can withstand such temperatures.

**Apply to be
 considered for a student
   award (Yes / No)?:**

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

MSc

**Main supervisor (name and email)
and his / her institution:**

Prof P.E Ngoepe, phuti.ngoepe@ul.ac.za, UNIVERSITY OF LIMPOPO

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

yes

Astrophysics / 350

Fluctuations in the Extragalactic Background Light and its Effects on the Hard Gamma Ray Spectrum

Author: Ayman Kudoda[1]

Co-author: Andreas Faltenbacher [2]

[1] *University of the Witwatersrand*

[2] *WITS*

Corresponding Author: aymankudoda@gmail.com

The interaction of Extragalactic Background Light (EBL) photons and gamma-rays from distant quasars results in the attenuation of the high energy tail of the gamma-ray spectrum. The attenuation depends on the EBL photon density. Clustering of galaxies on a scale of up to 100 Mpc causes fluctuations in the EBL photon density. We present an analytical model of the EBL fluctuations and discuss its effects on the hard gamma-ray spectra.

**Apply to be
 considered for a student
   award (Yes / No)?:**

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof Andreas Faltenbacher
Email:andreas.faltenbacher@wits.ac.za
School of Physics
Faculty of Science
University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Physics of Condensed Matter and Materials 1 / 353

mK-Scale Cooling of Nanoelectronic Devices in South Africa

Author: Samuel Wolski[1]

Co-author: Mark Blumenthal [1]

[1] *University of Cape Town*

Corresponding Author: wlssam007@myuct.ac.za

The Nanoelectronics Laboratory at the University of Cape Town has recently obtained the first sets of results from the new ultracold helium dilution fridge. First, the general working principles of the dilution fridge are discussed, including the mechanisms which enable the cooling of samples to temperatures of around 6mK. Following this, the first set of measurements in Africa of the Quantum Hall Effect (QHE) in a 2-Dimensional Electron Gas (2DEG) system are presented. The QHE is a fundamental measurement in the study of low-temperature condensed-matter systems, and is of particular importance in metrology as the basis for the international resistivity standard. The theory of 2DEG systems is also discussed, along with the relevance of experimental results in advancing the theoretical framework. Finally, preliminary results from and outlines for future experiments with more advanced nanoscale devices are presented and analyzed.

Summary:

A discussion of the first results from the ultracold helium dilution fridge at the University of Cape Town, along with a contextualisation in terms of fridge mechanics, applications, and future projects.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Hons

**Main supervisor (name and email)
and his / her institution**:

Associate Professor Mark Blumenthal
mark.blumenthal@uct.ac.za
University of Cape Town

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Physics Education / 354

The University of the Western Cape Department of Physics and Astronomy natural science and physical science teacher development and training program

Author: Mark Herbert[1]

[1] *University of the Western Cape*

Corresponding Author: msherbert@uwc.ac.za

The Teacher Development and Training Program for senior phase natural science and physical science teachers is an initiative of the University of the Western Cape Physics and Astronomy Department. The program aims to increase student retention, throughput and success in natural and physical science at high school, by developing senior phase natural and physical science teachers, physics content knowledge and pedagogical skills to deliver first rate physics teaching and learning. This paper reports on the University of the Western Cape Physics and Astronomy Department natural science and physical science teachers' Development and training program. An overview of the program will be presented.

**Apply to be
 considered for a student
   award (Yes / No)?:**

N0

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Theoretical and Computational Physics 1 / 355

Bottomonia Suppression in Heavy Ion Collisions from AdS/CFT

Author: Nadia Barnard[1]

Co-author: William Horowitz [1]

[1] *University of Cape Town*

Corresponding Author: brnnad007@myuct.ac.za

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. Using imaginary time techniques we numerically determine the real and imaginary parts of the binding energy of the bottomonia in a potential computed from AdS/CFT and one from pQCD. We then use these binding energies in a suppression model to determine the Y(1S) and Y(2S) nuclear modification factors and their double ratio. Most important, we investigate the consequences of the different velocity dependencies of these potential models on the bottomonia RAA(pT).

**Apply to be
 considered for a student
   award (Yes / No)?:**

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

Hons

**Main supervisor (name and email)
and his / her institution**:

Dr William A. Horowitz
wa.horowitz@uct.ac.za
University of Cape Town

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 65 / **356**

Jitter Analysis of Pulse-Per-Second Timing Signals Transmitted over Optical Fibre Networks

Author: KAGISO J LEBURU[1]

Co-authors: Andrew Leitch [2]; Duncan Boiyo [3]; Romeo Reginald Gunther Gamatham [4]; Timothy Gibbon [5]

[1] *NELSON MANDELA METROPOLITAN UNIVERSITY*

[2] *NMMU*

[3] *Centre for Broadband Communication, Nelson Mandela Metropolitan University*

[4] *NRF, Square Kilometre Array South Africa*

[5] *NMMU Physics Department*

Corresponding Author: leburujk@gmail.com

The telescope networks rely on high frequency clock tones to be distributed to each antenna for driving the digitizers, time stamping the data, and for monitoring and control functions. Stringent timing signals also find use in organisations like Square Kilometre Array, National Metrology Institute of South Africa, Coordinated Universal Time and Global Positioning System; as well as in areas of financial systems, telecommunications, transport, military, etc. However, clocks suffer from time deviation from the true periodicity, known as jitter. Jitter is contributed by noise, thermal effects, aging, etc. It can be either random or deterministic. In this study we analyse the jitter contributed by transmission of pulse-per-second (PPS) timing signals over typical optical fibre networks. The PPS timing signals were transmitted in G.652 Optical fibre of 3.21 km. The 1310 nm Vertical Cavity Surface Emitting Laser, biased at 4.79 mA, was modulated using PPS signals. The overall jitter contribution from the optical fibre transmission was found to be 0.202 femtoseconds. This means that the PPS signals' periodicity deviates by this value, and may cause signal delays in communication and timing systems. However, this value agrees within the typical acceptable jitter ranges of pico- to femtoseconds. For stringent timing applications, jitter correction mechanisms may be required to effectively compensate for the jittery in such systems.
Keywords: Timing signals, PPS, Jitter, Optical fibre networks

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof Tim Gibbon, Tim.Gibbon@nmmu.ac.za
Centre for Broadband Communication, Physics Department, Nelson Mandela Metropolitan University, P. O. Box 77000, South Campus, Summerstrand, Port Elizabeth, 6031, South Africa

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Physics of Condensed Matter and Materials 1 / 357

Structure and Phase Stability Study of Nickel Doped Spinel LiMn₂ O₄ using Cluster Expansion Method

Author: kemeridge Tumelo Malatji[1]

Co-author: Rapela Maphanga [1]

[1] *University of Limpopo*

Corresponding Author: kemeridge@gmail.com

The demand for lithium-ion batteries with higher specific energy and higher power capacity for application in electric vehicles and portable electronics has led to a search for electrode materials with much higher electrochemical performance than conventional materials. Spinel LiMn₂ O₄ is a low-cost, environmentally friendly, and highly abundant material and is used as a cathode material in Li-ion batteries. However, lithium manganese oxide (LMO) suffers from limited cycle life that is triggered by manganese dissolution into the electrolyte during electrochemical cycling. Doping in battery materials tends to improve the efficiency in maintaining electrochemical capacity over a large number of cycles without sacrificing initial reversible capacity at room temperature. In this paper, Universal Cluster Expansion (UNCLE) code implemented in cluster expansion formalism is used to investigate nickel doped LMO phase stabilities. The method determines stable multi-component crystal structures and rank metastable structures by enthalpy of formation, while maintaining the predictive power and accuracy of first-principles density functional methods. Complex configurations of nickel doped LMO systems with various concentrations are determined at different temperatures by means of Monte Carlo random sampling. The ground state phase diagram generated various structures with different concentrations and symmetries. The findings predict that nickel doped LMO with 50:50 concentration of manganese and nickel is the most stable phase.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Phd

**Main supervisor (name and email)
and his / her institution**:

Maphanga R.R.
Rapela.Maphanga@ul.ac.za
University of Limpopo

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Applied Physics / 358

Short-Term Stability of RF Clock Signal Distribution System Over Different Optical Fibres

Author: Phumla Dlamini[1]

Co-authors: Andrew Leitch [2]; Romeo Reginald Gunther Gamatham [3]; Timothy Gibbon [4]

[1] *Nelson Mandela Metropolitan University*

[2] *NMMU*

[3] *NRF, Square Kilometre Array South Africa*

[4] *NMMU Physics Department*

Abstract: The Square Kilometre Array (SKA) and MeerKAT telescope networks rely on highly stable and precise Radio Frequency (RF) clock tone used as timing and synchronization signals transmitted over optical fibre from a central point to remote antennas. The distribution system of an RF clock signal over optical fibre occurs in stages: optical clock signal generation, transfer over optical fibre, receiving of optical signal and conversion to electrical signal; ensuring the signal maintains a certain level of frequency stability for successful operation of the telescope. This is problematic as there is phase deviation introduced as the signal propagates along the optical fibre associated with a change in time delay resulting in a decrease of frequency stability. The phase fluctuation is due to intensity noise, optical fibre loss and chromatic dispersion that is associated with carrier wavelength, transfer distance, and the coefficient of chromatic dispersion respectively. In this work, the received power dependent short-term instability induced on RF clock signal during transmission of different optical fibre types was measured and analysed in the frequency domain. The RF clock tone phase noise at 10 kHz offset frequency was measured as − 108.13 dBc/Hz. Upon transmission over a 22.3 km cabled G.652.C optical fibre and a 23.8 km G.655 spool the phase noise at 10 kHz offset frequency increased to − 105.35 dBc/Hz and − 103.00 dBc/Hz, respectively.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Timothy B. Gibbon
Nelson Mandela Metropolitan University

Tim.gibbon@nmmu.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Applied Physics / 359

Investigating the dynamic flow within tumbling mills.

Author: Graham Daniels[1]

Co-author: Andy Buffler [2]

[1] *Necsa*

[2] *University of Cape Town*

Corresponding Author: graham.daniels@necsa.co.za

Tumbling mills are an important part of mineral processing systems, which makes use of the comminution process to break down a large body into smaller pieces by crushing and grinding. The shape and flow of the internal bulk is important in understanding the effectiveness of the comminution process. In this investigation we make use of the technique of fast neutron radiography, at the PTB cyclotron in Braunschweig, to examine the behaviour of the bulk within a tumbling mill having

internal mixes of steel, wood and plastic pellets. The layering and shapes of the bulk are observed via radiography, this used to infer the motion, density distribution and effective mixing of the bulk which impacts the comminution process.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Professor Andy Buffler
andy.buffler@uct.ac.za
University of Cape Town

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Nuclear, Particle and Radiation Physics 1 / 360

Study of the low-lying states in ²⁶ Mg nuclei.

Author: Pheladi Molema[1]

[1] *Student*

Corresponding Author: topzeemolema@gmail.com

The study of ²⁶ Mg level structure is of particular importance in nuclear structure physics because of its impact in the slow neutron capture process (s-process) for the nucleosynthesis of heavy elements up to lead. In fact, the ²⁶ Mg is the compound nucleus for the s-process neutron source ²²Ne (α, n)²⁵ Mg that is one of the dominant reaction in the s-process. Since it is an endothermic reaction it competes directly with the ²² Ne (α,γ) ²⁶ Mg radiative capture. Understanding the rate of both of these reactions is crucial for linking the observational evidence of s-process abundance with the internal structure of the stars. The uncertainties in the energy of the ²⁶ Mg states and the inconclusive spin- parity assessments still lead in large error bars in these reaction rates.

In this work, the low-energy states in ²⁶ Mg were populated using the inelastic scattering of alpha particles with beam energy of 120 MeV. The ²⁶ Mg (α,α'γ)²⁶ Mg measurements can be useful to improve the uncertainties in these rates by studying and extracting the characteristics of the excited states of ²⁶ Mg. The experiment was performed at iThemba LABS research facility using a new designed experimental set-up: the K600 magnetic spectrometer coupled to the BaGeL array (Ball of Germanium and LaBr detectors). This combination was used to perform the coincidence measurements between charged particles and gamma rays. The excitation and the subsequent gamma decay of the ²⁶ Mg states of interest will be investigated. Preliminary results on the analysis will be presented.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof. E. Sidderas-Haddad
Witwatersrand university

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Theoretical and Computational Physics 1 / 361

Two gluon correlation

Author: Andriniaina Narindra Rasoanaivo[1]

Co-author: William Horowitz [1]

[1] *University of Cape Town*

Corresponding Author: andriniaina@aims.ac.za

In this presentation we want to motivate a new technique to compute the momentum distribution for emission of an arbitrary number of gluons radiated from a high-pT quark passing through a QCD medium. The technique is an extension of the maximal helicity violating (MHV) method in which the usual soft-collinear factors are classified according to the gluon permutations
symmetry. Based on the single gluon emission distribution, first we will present the distribution for the two gluon emissions in the assumption of a Poisson distribution. Second, we will show a rigorous technique using the MHV to compute the same distribution, and last we extract the non-abelian effect that break the Poissonnian pattern.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Dr WA Horowitz (wa.horowitz@uct.ac.za) at UCT

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 22 / **363**

Characterization of defects in BaF2 using postron annihilation and XRD techniques

Author: Thulani Jili[1]

Co-authors: Daniel Wamwangi [2]; ELIAS SIDERAS-HADDAD [3]

[1] *University of Zululand*

[2] *wits university*

[3] *University of the Witwatersrand*

Different experimental techniques have clearly demonstrated that the predominant intrinsic point defects in ionic barium fluoride are anion Frenkel pairs. We utilized positron annihilation technique in obtaining Doppler broadening spectra in the temperature range 300 − 900 K. Theoretical approach uses the density functional theory and the generalized gradient approximation which calculate the Doppler broadening spectra. The Ba-atom contribution towards electron-positron annihilation momentum density increases steadily with temperature. 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 rate of disordering of fluorine sub-structure is found to increase non-linearly from a temperature of 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 conductivity of 4.64 × 10-7 Ohm-1 cm-1 is first observed. This is demonstrated through the correlation between the lattice constants and the conductivity values at elevated temperatures.

**Apply to be
 considered for a student
   award (Yes / No)?**:

no

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

n/a

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Applied Physics / 364

Capacitance Measurements on Potential Induced Degradation of Polycrystalline Silicon Solar Cells

Author: Gilbert Osayemwenre[1]

Co-authors: Edson Meyer [2]; Raymond Taziwa [3]

[1] *FHIT*

[2] *University of Fort Hare*

[3] *Fort Hare*

Corresponding Author: gosayemwenre@ufh.ac.za

Polycrystalline silicon (poly-Si) solar cells, in the absence of effective and substantive electrical protection, are very susceptible to point defect formation. Naturally this would occur if the cell were reversed bias by its adjacent string cells when it is partially shaded, say.
For this study we have induced degradation on a single partially shaded poly-Si cell through reverse biasing the cell under illumination of 100 mW/cm2. Degradation of the cell was confirmed through current-voltage (I-V) measurements before and after degradation. Before the induced degradation, capacitance-voltage (C-V) measurements were used to establish the doping density and build-in voltage at the cell junction, both in the dark and under illumination. The depletion width or space charge region of the junction and the average diffusion length were also estimated. After the induced degradation, these parameters were measured again under the same conditions.
Apart from the observed morphological damage to the micro morph of the polycrystalline structure, a significant reduction in the build-in voltage was observed. In addition, the decrease in the diffusion length indicated that new interstates were formed due to junction breakdown, allowing the electrons to recombine in a comparatively shorter distance from where it is generated towards the depletion region edge.
The final paper will give a detailed account of the observed induced degradation, its effect on doping

density, build-in voltage and the total thickness of the cell that is contributing to the photo-generated current.

Keywords: Polycrystalline Silicon Solar Cells, Capacitance-Voltage Measurements, Performance Degradation, Build-in Voltage, Doping Density, Depletion Width

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Astrophysics / **365**

Analytic Tools for the Study of Cepheid and Other Variable Stars

Author: Nigist Beyene[1]

Co-authors: Lerothodi Leeuw [2]; Patrice Okouma [3]

[1] *AIMS South Africa*

[2] *University of South Africa*

[3] *UWC*

Corresponding Author: lerothodi@alum.mit.edu

We introduce analytic tools we are designing for the study of cepheid and other variable stars. The study and analysis will include long terms variability analysis of these variable stars, using both archival and new data, and thus have potential to not only probe the physical properties of the stars, but also their evolutionary characteristics and use as distance probes.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Lerothodi Leeuw, Lerothodi@alum.mit.edu, UNISA

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Nuclear, Particle and Radiation Physics 2 / **366**

Measurement of W and Z boson production in p-Pb collisions at √s_{NN} = 5.02 TeV in ALICE

Author: AMAL SARKAR[1]

Co-author: Collaboration ALICE [2]

[1] *NRF iThemba LABS, Cape Town*

[2] *LHC, CERN*

The production of electroweak W[±] and Z⁰ bosons is extensively studied at the CERN Large Hadron Collider (LHC) because they are important benchmarks of the Standard Model. Due to their masses, they are produced in hard scattering processes occurring at the early stage of a collision and they interact weakly, therefore, they are not affected by the strong interaction. Therefore, they can be used as a reference for medium induced effects. In p-Pb collisions, their production can be used to study the modification of parton distribution functions in the nucleus and to test the validity of binary collision scaling while in pp collisions their cross sections are known with a precision limited by the parton distribution function (PDF) uncertainties. The production of W and Z bosons is one of the best-understood processes and the hard scattering cross sections have been calculated up to the next-to-next-to-leading order (NNLO) approximation.

In ALICE the measurements of W and Z boson production are performed via the muonic decay channel in p-Pb collisions at √s_{NN} = 5.02 TeV at forward (2.03 < y_{cms} < 3.53) and backward (-4.46 < y_{cms} < -2.96) rapidities. The measured cross sections will be presented and they will be compared to perturbative Quantum Chromodynamics calculations at next-to-leading order. In addition, an outlook study of W boson production in Pb-Pb collisions at √s_{NN} = 5.02 TeV will be discussed.

**Apply to be
 considered for a student
   award (Yes / No)?**:

NO

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 66 / **367**

Characterization and Classification of a 5-kW Xenon Lamp Solar Simulator with an Ellipsoidal Reflector

Author: Cuthbert Makosa[1]

Co-authors: Edson Meyer [2]; Gilbert Osayemwenre [3]; Raymond Taziwa [1]

[1] *Fort Hare University*

[2] *University of Fort Hare*

[3] *FHIT*

Corresponding Author: gosayemwenre@ufh.ac.za

Solar photovoltaic (PV) modules are generally guaranteed to provide up to 85% of their rated power after 25 years of outdoor exposure. However, a number of factors, be it inherent to the PV technology or due to the environment, can result in premature performance degradation and even electrical failure.
In order to monitor the module's performance, without the influence of the constantly changing outdoor operating conditions, it is necessary to use a solar simulator where the light intensity (100 mW/cm2), module temperature (25ºC) and air mass between the light source and the target area

(AM 1.5 global spectrum) are constant even after 25 years. These constant conditions constitute the Standard Test Conditions (STC), which are universally accepted for solar simulators.
For this study, a steady state simulator was designed, built, characterized and classified. The 5-kW Xenon lamp simulator with ellipsoidal F2.5 reflector was characterized in terms of (i) the spectral match to the AM 1.5 global spectrum with a 100 nm bandwidth from 300 nm to 1100 nm, (ii) the irradiance spatial uniformity as measured with a class A pyranometer and (iii) the temporal instability over both short- and long-term periods. These three criteria were measured over an effective target area of 1.5 m x 1.5 m (at a grid size of 5 cm x 5 cm), with source-to-target distances varying from 2.0 m to 6.0 m. As per the IEC 60904-9-2007, ASTM and JIS specifications, the designed simulator conforms to an AAA rating. That is, the measured spectra were within 0.75 - 1.25 times the AM 1.5 global spectrum (A), ≤ 2% spatial non-uniformity over the entire target area (A) and < 2% long-term instability (A).
Furthermore, current-voltage (I-V) measurement reproducibility of the simulator was evaluated for various PV modules technologies and the results indicated a confidence level of more than 95%. This paper will detail the design of the simulator, methodology for AAA rating, its results and reproducibility of the I-V measurements of various PV technologies.

Keywords: AAA Solar Simulator, STC, Spectral Match, Irradiance Spatial Uniformity, Temporal Instability, I-V measurements

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Hons

**Main supervisor (name and email)
and his / her institution**:

Edson L. Meyer
Email:Emeyer@ufh.ac.za

Fort Hare Institute of Technology, University of Fort Hare
Private Bag X1314, Alice, 5700, Eastern Cape, South Africa

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 85 / **368**

Focused Ion Beam Imaging of Induced Defects in Polycrystalline Silicon Solar Cells

Author: Gilbert Osayemwenre[1]

Co-authors: Edson Meyer [2]; Raymond Taziwa [3]

[1] *FHIT*

[2] *University of Fort Hare*

[3] *Fort Hare University*

Corresponding Author: gosayemwenre@ufh.ac.za

Potential induced degradation (PID) is expected to cause both morphological and crystallographic damage in polycrystalline silicon (poly-Si) solar cells due to its microstructure and inherent grain boundaries. Formation of hotspots is caused, more often than not, from under-performing solar cells connected in series with other cells. This may be a result of mismatching during the batching stage of assembly, inconsistent anti-reflective coating, uneven degradation of the encapsulating material

due to UV exposure, moisture ingress and even something as benign as a falling leaf.
For this study we have intentionally mismatched a cell in a polycrystalline cell string to induce hotspot formation. I-V measurements confirmed the mismatch in the cell string while infrared thermography confirmed the formation of hotspots. The targeted (mismatched) cell was then isolated from the string for further analyses. The first step was to identify the damaged regions on the cell and establish the Si vibrational modes in the damaged regions as compared to that of the un-damaged regions through Confocal Raman Spectroscopy. SEM analysis revealed that hotspots were formed since carbon was prevalent in the observed damaged regions.
Focused Ion Beam (FIB) analysis allowed the systematic, controlled removal of layers of pre-determined thickness to establish whether indeed the p-n junction structure still exists within these damaged regions. Results obtained show that once the junction breakdown voltage of polycrystalline Si is reached, catastrophic changes in both the morphology and crystallography of the cell can significantly reduce the power producing capability of the cell. The final paper will present these results in detail through FIB imaging.

Keywords: Polycrystalline Silicon Solar Cells, Hotspot Formation, Morphological and Crystallographic Damage, Focused Ion Beam

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Edson L. Meyer
Email: Emeyer@ufh.ac.za

Fort Hare Institute of Technology, University of Fort Hare
Private Bag X1314, Alice, 5700, Eastern Cape, South Africa

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 55 / **369**

Neutron Capture Cross Sections of S-process Branch-Point Nuclei

Author: Bonginkosi Kheswa[1]

[1] *University of Johannesburg*

Corresponding Author: vincentk@uj.ac.za

At certain locations in the s-process path, there are unstable nuclei with beta-decay rates comparable to the neutron capture rates. This opens up a new possible pathway for the s-process: instead of just undergoing beta decay, the radioactive nucleus could also survive long enough to capture a neutron. Hence, the s-process splits into two branches; these special cases are called s-process branch-point nuclei and they are of special interest because they provide information on the stellar neutron density at the s-process site [1]. On the other hand, they are problematic because their (n,&gamma) cross section is usually not accessible via direct measurements. Three such branch-point nuclei are addressed in this project: 185W, 186Re and 186Os, which are of particular interest due to the Re-Os cosmochronology: the 187Re −187Os pair may be used as a cosmochronometer to determine the duration of the stellar nucleosynthesis before our solar system as formed [2]. However, the existence of the above mentioned branch-points induces complications[3]. Hence an improved determination of the (n, &gamma) cross-sections for these nuclei is essential. In this conference I will

present the newly determined cross-sections of 184, 185, 186W(n, &gamma) reactions which have been constrained using the experimental nuclear level densities and photon strength functions of 185, 186, 187W nuclei. These statistical nuclear properties were measured at the cyclotron laboratory of Oslo using 186W(d, X) reactions (where X = p, d, t) and beam energy of 13 MeV.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Applied Physics / 370

A Passive Solar Building Response to Selective Components of Solar Irradiance

Author: ochuko Kelvin overen[1]

Co-authors: Carine L. Buma [1]; Edson Meyer [1]

[1] *University of Fort Hare*

Corresponding Author: ooveren@ufh.ac.za

Solar radiation provides the most significant natural energy in buildings. Due to atmospheric interference, solar radiation received at the earth surface consists of direct beam and global irradiance, where diffuse can be further broken down into short and long wave irradiance. Although each of these components occur simultaneously, their individual influence on the indoor condition of a building differs. The aim of this study is to analyze the influence of the various components of solar irradiance on the indoor temperature, relative humidity and illuminance level of a passive solar building in Alice in the Eastern Cape. To this effect, a SOLYS 2 dual Axis Sun tracker system, comprising of a set of four radiometers were used to measure the various solar radiation components. These include direct beam, diffuse, tilted and downward long wave irradiance. The indoor temperature and relative humidity was measured by HMP 60 temperature relative humidity probe. A Li-210R Photometric sensor was used to measure the indoor illuminance. Preliminary results show that on a typical sunny day, the indoor temperature and relative humidity have a linear and inverse response, respectively, to the various solar irradiance components. A minimum response time of 1 hour was observed between the indoor temperature and diffuse irradiance. While a 30-minute response time between the indoor relative humidity and direct beam irradiance was noticed. Relative to other solar radiation components, it was found that the indoor temperature is statistically predicted best by a linear combination of global, tilted and downward longwave irradiance. Whereas, a combination of direct beam, diffuse, as well as downward longwave irradiance are suitable to predict indoor relative humidity. A meticulously developed model to predict the indoor conditions of the building will also be discussed with particular emphasis on the sensitivity of the model to the various irradiance components.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof Edson L. Meyer, emeyer@ufh.ac.za
Fort Hare Institute of Technology, University of Fort Hare

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 67 / **371**

Design and fabrication of a biogas fermentation system

Author: KeChist Obileke[1]

Co-authors: Edson Meyer [1]; Golden Makaka [1]; Sampson Mamphweli [1]

[1] *University of Fort Hare*

Corresponding Author: kcobileke@yahoo.co.uk

Previous designs of biogas fermentation systems have the challenge of cracking that take place especially at the brick structure after a short period of operation. These biogas fermentation systems are usually constructed using bricks and cements. The choice of material, design and size of the system plays an important role in the successful of the fermentation system.
In this study, a 2200 litres capacity high density polyethylene (HDPE) plastic material was designed and fabricated. The type of plastic chosen was as a result of its properties, such as; high strength, anti-aging, corrosion resistant, light weight, good tightness and life span of more than 30 years. The AutoCAD software was used for the design and also the process of rotational moulding for the fabrication of the material. This technique makes use of high temperature, low pressure plastic forming process that uses heat and biaxial rotation to produce hollow of one piece part.
The design and fabrication employs the use of plastic and bricks material. Based on the authors' knowledge through literature, no such design has been done before. This is a major breakthrough in the study. This type of design has the potential of creating employment opportunity for both the skilled and unskilled labour and is of low cost effective.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. Mamphweli Sampson
smamphweli@ufh.ac.za
Fort Hare Institute of Technology (FHIT)
University of Fort Hare

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Photonics / **372**

Tailoring light in the mid-IR

Author: Lucas Gailele[1]

Co-authors: Andrew Forbes [2]; Angela Dudley [3]; Loyiso Maweza [2]

[1] *Csir*

[2] *CSIR*

[3] *CSIR National Laser Centre*

Corresponding Author: lgailele@csir.co.za

Optical communication systems optimize multiplexing in polarization and wavelength both transmitted in fiber and free-space to attain high bandwidth data communication. We are expected to reach a bandwidth ceiling in the near future due to non-linear effects in fiber. Communications using orbital angular momentum (OAM) carrying modes offers infinite dimensional states, providing means to increase link capacity by multiplexing spatially-varying modes in both the azimuthal and radial degrees of freedom. OAM modes are multiplexed and de-multiplexed by the use of spatial light modulators. Implementation of complex amplitude modulation is employed on a laser beam's phase and amplitude to generate Laguerre-Gaussian modes. The modal decomposition technique is employed to detect these modes due to their orthogonality as they propagate in space. We demonstrate data transfer by sending images as a proof-of concept in a lab-based scheme. We demonstrate the creation and detection of OAM modes in the mid-IR region as a precursor to a mid-IR free-space communication link and attempt to improve data transmission in the atmosphere and show improved image resolution by reconstructing the wave front of mid-IR light.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Msc

**Main supervisor (name and email)
and his / her institution**:

Prof Andrew Forbes
Andrew.Forbes@wits.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 78 / **373**

Shaping light with a mid-IR spatial light modulator

Author: Lucas Gailele[1]

Co-authors: Andrew Forbes [2]; Angela Dudley [3]; Loyiso Maweza [2]

[1] *Csir*

[2] *CSIR*

[3] *CSIR National Laser Centre*

Corresponding Author: lgailele@csir.co.za

Traditionally it has been custom to shape light using static diffractive optical elements (DOEs) tailored to a specific application giving only one shape. However the invention of spatial light modulators (SLM) which have nematic liquid crystals that are able to be controlled electronically to shape the phase of an optical beam into different patterns in real time. This innovation proved to be an efficient way to shape light without having a multiple and different DOEs. These devices however are wavelength depended and calibration is needed. We will discuss how we calibrate a mid-IR spatial light modulator using interferometry and also measure it diffraction efficiency.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Msc

**Main supervisor (name and email)
and his / her institution**:

Andrew Forbes
Andrew.Forbes@wits.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Theoretical and Computational Physics 1 / 374

NLO Dynamics of Falling Strings in AdS/CFT

Author: Nicole Moodley[1]

Co-author: William Horowitz [1]

[1] *University of Cape Town*

Corresponding Author: nicole.a.moodley@gmail.com

We use the gauge/gravity duality to compute the penetration depth of a quark moving through a strongly-coupled N = 4 SU(N_c) super-symmetric Yang-Mills plasma. Using numerical techniques, we study the effect of next-to-leading order fluctuations on the holographic string in AdS₅-Schwarzchild.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Hons

**Main supervisor (name and email)
and his / her institution**:

Dr W.A. Horowitz, University of Cape Town

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Applied Physics / 375

Energy Management in the Balance of System Components in a Stand-Alone Building Integrated Photovoltaic System

Author: Carine Buma[1]

Co-authors: Edson Meyer [2]; Raymond Taziwa [1]

[1] *Fort Hare Institute of Technology*

[2] *University of Fort Hare*

Corresponding Author: emeyer@ufh.ac.za

Only 17% of South Africa's energy comes from renewable sources even though this country is endowed with rich solar resources of 220 W/m2 as compared to Europe's 120 W/m2 and the USA's resource of 100 W/m2. The use of Building Integrated Photovoltaic (BIPV) systems for its three decades of existence has claimed only a 1% share of the total photovoltaic installations worldwide. Very little of this technology has been reported in South Africa. The aim of this work is to evaluate the performance of the balance of system components in a stand-alone BIPV system, and to account for the energy flow in the system. It is imperative to have an in-depth understanding of the underlying factors governing the charging and discharging regimes of the battery, the low voltage disconnect and high voltage reconnect regimes of the load and type of charging regimes under the maximum power point tracking (MPPT) algorithm on the modules.
This paper disseminates the intricate relations between the various regimes in detail. Results obtained show that, with a demand of 4.5 kWh/day, just 58.4% of this system's potential is used. If this system is connected to the grid, it will feed energy worth R623,40/month to the grid, which is unused (wasted) due to the MPPT charge controller regulations. This amount is based on the local municipality tariff. Also, the inverter's peak efficiency is 80.5%. This efficiency goes down to 31.2% when operated at 0.8% of its capacity. The battery round trip efficiency is 93%.

Summary:

Building Integrated Photovoltaic System, Renewable Energy Feed-in Tariffs, Stand-alone Photovoltaic System, inverter Peak Efficiency

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof. Edson L. Meyer (emeyer@ufh.ac.za)
Fort Hare Institute of Technology
University of Fort Hare

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Astrophysics / **376**

Investigating electronic pedestals of the analogue front-end boards of the upgraded High-Energy Stereoscopic System (H.E.S.S.-I) cameras

Author: Kleopas Shiningayamwe[1]

[1] *The University of Namibia*

Corresponding Author: shiningayamwe.kp@gmail.com

The High-Energy Stereoscopic System (H.E.S.S.) is an array of five imaging atmospheric Cherenkov telescopes located in the Khomas Highland in Namibia, dedicated to very-high-energy (VHE, 100 GeV - 100 TeV) gamma-ray astronomy. It consists of four identical 12 m diameter telescopes (H.E.S.S.-I) which started operating in 2003 and a large 28 m diameter telescope (H.E.S.S.-II) which was brought online in 2012.

The H.E.S.S.-I camera upgrade project was aimed to increase the stability and performances of the camera operation by replacing the 13 years old camera electronics with modern-day technologies. The most delicate parts of the upgraded electronics are the readout boards of the drawers, which have been upgraded with a new analog memory. A significant level of cross-talk has been observed in the analog front-end boards of the H.E.S.S.-I camera upgrade. The observation of such level of cross-talk motivated a deeper study of the electronic pedestals of the upgraded H.E.S.S.-I cameras, as pedestal studies could help to understand the origin of such a cross-talk. The cameras require a low level of noise in their electronics in order to capture the faint light and individual Cherenkov photons. Also, a low level of noise in the camera electronics improves the accuracy in the interpretation of the data which in turn leads to better results from the data taken with these cameras.
A C++ code written in ROOT modular scientific software framework has been developed for the analysis of the data taken with a drawer on the Test bench at DESY in Zeuthen, Germany. So far, from the computation of the auto-correlation function and Fourier transform of the electronic pedestals, no characteristic patterns have been found to explain the level of cross-talk observed. The investigations of the noise level of the rear part of the electronic boards will be continued.

Summary:

The abstract discusses the front-end electronics of the cameras of the H.E.S.S.-I Cherenkov telescopes after the upgrade. The work investigates the possible reasons for cross-talk between several detector channels, mainly through a time and periodicity analysis. No systematic repetition or periodicity of the studied electronic pedestals nor any reason for the cross-talk has been found.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Dr Michael Backes
mbackes@unam.na
The University of Namibia

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 68 / **377**

Solar Metrology at the Fort Hare institute of Technology, Alice, South Africa

Author: Carine Buma[1]

Co-authors: Edson Meyer [1]; Kelvin Overen [1]; Raymond Taziwa [1]

[1] *Fort Hare Institute of Technology*

Corresponding Author: emeyer@ufh.ac.za

The sun is the major source of energy on the planet and is at the center of all the other energy sources. The energy generated by the sun is more than enough to take care of the earth's energy needs. Knowledge of the solar characteristics for a particular location is very important to different fields of study, amongst which are solar photovoltaic systems. The existing literature on solar characterization of various locations, deals mainly with locations in the Northern hemisphere. Applying the same procedures to locations in the southern hemisphere can be very cumbersome and confusing at times.
Therefore, the aim of this work is to do an in-depth analysis of the solar characteristics at the Fort Hare Institute of Technology located in the Southern hemisphere. The parameters examined include;

variations in the solar altitude, zenith angle, azimuth angle, sunrise time, sunset time, solar noon, direct, diffuse and reflected solar insolation, solar declination, equation of time, solar analemma and air mass ratio for a period of one year. Furthermore, an analysis of the yearly weather patterns such as rainfall, wind speed and direction, ambient temperature and relative humidity were also examined. Existing mathematical models from literature were used to do the analyses and a real time simulation was developed on an excel spreadsheet to for the various parameters to see how they each change at various hours of the day for the entire year. This calculated data were then superimposed on data measured by a recently installed, comprehensive Solar Measurment Station. The science of the solar measurment or solar metrology forms the basis for the paper.

Summary:

Solar Metrology, Solar Altitude, Solar Noon, Solar Analemma

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof. Edson L. Meyer (emeyer@ufh.ac.za)
Institute of Technology
University of Fort Hare

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 23 / **380**

Computational modelling studies of O2/Pt surface for fuel-cell application

Author: Prettier Maleka[1]

Co-authors: Hasani Chauke [1]; Peace Prince Mkhonto [1]; Phuti Ngoepe [1]

[1] *University of Limpopo*

Corresponding Author: hr.chauke@ul.ac.za

Ab-initio density functional theory with the generalized gradient approximation was used to investigate the interaction of oxygen molecule with the Pt (100), (110) and (111) surfaces. The oxidation of Pt may lead in the development and enhancement of the catalytic activity of fuel-cells, especially those operating at low temperatures, such as proton exchange membrane fuel cells and proton conducting membrane fuel cells. The optimization of the non-adsorbed platinum surfaces reflected that the (111) surface is the most stable surface. Three adsorption sites were considered, the bridge, hallow and Pt-top. For oxygen molecule adsorption on Pt, we observed a superoxide (Pt-O-O) formation on (100) surface while on (110) surface a bridge bonding (Pt-O-O-Pt) is observed. The adsorption energy indicated that on the (100) surface, the Pt-top adsorption site is more exothermic than bridge and hollow sites. Furthermore, the electronic density of state show strong Pt 3d and O 2p hybridization which is attributed to the strong adsorption energy.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Hasani Chauke
University of Limpopo

hr.chauke@ul.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Theoretical and Computational Physics 1 / 381

Theoretical characterization of beryllium and nitrogen co-doped graphene: a proposed p-type semiconductor for nanoelectronic devices

Author: Okikiola Olaniyan[1]

Co-authors: Abubakar Khaleed [2]; Edwin Mapasha [2]; Emmanuel Igumbor [2]; Ncholu Manyala [2]

[1] *UP*

[2] *University of Pretoria*

Corresponding Author: okikiola.olaniyan@yahoo.com

Ab-initio calculations within the framework of density functional have been performed to study the electronic properties of Be and N co-doped graphene. The results have been compared with that of Be-doped, N-doped and pristine graphene. The effect of doping and isomerization on the electronic properties of these systems have been studied by varying the impurity concentrations of Be-doped and N-doped graphene systems from 3.13 through 12.5 %, while for Be and N co-doped graphene, the concentration have been varied from 6.25 through 25.0 % impurity concentration.The formation energies of the systems with different impurity configurations were calculated to examine their relative stabilities. It was found that for Be-N co-doped graphene, N and Be coexisting as the nearest neighbours is energetically the most favourable configuration. Moreover, at the same impurities concentration, Be-N co-doped graphene was observed to be more stable than Be-doped graphene due to its lower formation energy. Thus these results reveal that it is much easier to synthesize Be-N co-doped graphene than to synthesize Be-doped graphene. Hence, the relatively high formation energy of Be-doped graphene could be the reason why the system is yet to be synthesis experimentally.
The results of the electronic structure calculations reveal that Be-N co-doped and Be-doped graphene are p-type semiconductors while N-doped graphene has been verified to be n-type semiconductor. For all the doped systems considered, it was observed that the size of the band gap increases with impurity concentration with respect to the aforementioned energetically most favourable isomer. At impurity concentration of 3.13 %, a minimum band gap of 0.44 eV and 0.21 eV was realised for Be-doped and N-doped graphene respectively while at 12.5 % corresponding maximum gap of 1.41 eV and 0.6 eV were observed. Besides, Be-N co-doped graphene were found to have a minimum band gap of 0.43 eV at 6.25 percent and a maximum gap of 1.54 eV at 25.0 % impurity concentration.
The results of our study demonstrate that the band gap of graphene can be tailored to meet the requirements of specific applications in nanoelectronic devices.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. Ncholu Manyala
ncholu.manyala@up.ac.za
University of Pretoria

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Astrophysics / **382**

Optimasation of galaxy identification methods in large HI surveys

Author: Thembaloxolo Gqaza[1]

Co-authors: Anja Schröder [2]; Bradley Frank [1]; Renee Kraan-Korteweg [1]; Tom Jarrett [1]

[1] *University of Cape Town*

[2] *SAAO*

Corresponding Author: gqztem001@myuct.ac.za

The future of analysing HI-data cubes with respect to understanding the evolution of the neutral gas content in galaxies will take a giant leap forward. This is due to the advent of the HI-survey projects
that will be pursued with the Square Kilometer Array (SKA) and its Pathfinders. The forthcoming HI-surveys will produce spectral data cubes of unprecedented size. In preparation for the huge data volumes that will be generated, various automated source identification and parametrisation applications have been developed (e.g. SOFIA; see Serra et al. 2016). While these algorithms have
been thoroughly tested on simulated HI data cubes (see Popping et al. 2012), they have not yet been evaluated in any systematic way on real data. In this paper, we present a comprehensive analysis of various source identification and parameterization methods of a three-dimensional large
HI data cube obtained with the Westerbork Synthesis Radio Telescope (WSRT). The source-finding and parameterisation tools conform of visual, fully-automated, and semi-automated inspection. Each source-finding method is applied to the WSRT data cube, as well as a simulated data cube with equivalent parameters to the WSRT cube. The latter is used for quantifying reliability and completeness of the three methods. The final results will allow optimisation of the various algorithms.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof Renee Kraan-Korteweg <renee.kraankorteweg@gmail.com>
University of Cape Town

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 37 / **383**

An Implementation and Evaluation of Machine Learning Methods for Morphological Galaxy Classification

Authors: Julius Stopforth[1]; Roy Eyono[1]; Victor Gueorguiev[1]

[1] *University of Cape Town*

Corresponding Author: grgvic001@myuct.ac.za

We present a novel summary and comparison of various machine learning methods for morphological classifications of galaxies from the Sloan Digital Sky Survey (SDSS). We re-implement these methods in an open-source and publicly available repository, and examine the accuracy of these methods in reconstructing ground-truth expert knowledge distributions from previous crowd sourcing work, as well as provide an analysis and comparison of the performance of the methods selected. Projects such as Galaxy Zoo, a large scale crowd sourcing initiative using human/expert knowledge to classify a subset of data from the SDSS, produced large labelled datasets of galaxies which has seen both crowd sourced solutions and methods in literature attempting to match classification accuracy of experts. By conducting such a study in an open-source manner, this work will allow future methods to be quickly compared and evaluated against a sizeable subset of existing methods.

Summary:

We present a novel summary and comparison of various machine learning methods for morphological classifications of galaxies from the Sloan Digital Sky Survey (SDSS), and implement these methods in an open-source publicly available repository.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Hons

**Main supervisor (name and email)
and his / her institution**:

Deshen Moodley; Professor in the Department of Computer Science, University of Cape Town; deshen@cs.uct.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Nuclear, Particle and Radiation Physics 1 / 384

Exploring the nature and strength of the Isoscalar Giant Monopole Resonance in ¹²C

Author: Frederick David Smit[1]

Co-authors: Elias Khan [2]; Evgenii Nikolski [3]; George O'Neill [4]; Kevin Li [5]; Lindsay Donaldson [6]; Luna Pellegri [7]; Mohamed Kamil Mohamed [8]; Paul Papka [9]; Phil Adsley [2]; Retief Neveling [1]; Vicente Pesudo [4]

[1] *iThemba LABS*

[2] *Institut Universitaire de France, Institut de Physique Nucleaire, Orsay, IN2P3- CNRS, France*

[3] *3 National Research Centre, "Kurchov Institute", Kurchov sq 1,123182, Moscow, Russia and Flerov Laboratory of Nuclear Reactions, JINR, 141980 Dubna, Russia*

[4] *Department of Physics, University of Western Cape, Private Bag X17, Bellville 7535 and iThemba LABS, P. O. Box 722, Somerset West 7129*

[5] *Stellenbosch University, iThemba Labs*

[6] *iThemba LABS, P. O. Box 722, Somerset West 7129*

[7] *University of Witwatersrand and iThemba LABs*

[8] *University of the Western Cape*

[9] *Stellenbosch University*

Corresponding Author: smit@tlabs.ac.za

The excitation region centered around 10 MeV in ¹²C is characterized by several broad overlapping states. Recent Anti-symmetrized Molecular Dynamics cluster calculations show that the Isoscalar Giant Monopole Resonance (ISGMR) may have two components and that the smaller amplitude oscillation may contribute to the strength in this region. It is proposed to measure the ¹⁴C(p,t)¹²C reaction at 0 degrees for comparison to the ¹²C(alpha,alpha') reaction at 0 degrees. The (p,t) reaction is expected to only weakly excite the ISGMR while the (alpha, alpha') reaction excites it strongly. A comparison of the two excitation modes will help to unravel where the contributions of the ISGMR are in the excitation energy spectra of ¹²C. Some very preliminary results from the (p,t) experiments will be shown.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Physics Education / 385

Undergraduate students' difficulties with motion of hooked objects on inclined and horizontal surfaces

Author: Itumeleng Phage[1]

[1] *Central University of Technology, Free State*

Corresponding Author: iphage@cut.ac.za

The purpose of this study was to investigate the conceptual knowledge and skills of undergraduate physics students on the motion of two objects on a surface, inclined and or horizontal. The study was conducted with 103 introductory physics students in B.Ed (FET) Natural Science programme at Central University of Technology (CUT), Free State, Bloemfontein campus. A pre-test was administered to test and investigate their pre-knowledge of concept. The test was on problem-solving on the concept. The results indicated that the majority (more than 80%) of students had huge difficulties with where and how to start in order solve these problems. They lacked basic knowledge of free-body diagram and vector analysis and as a result they could not apply or deduce equations to solve. A follow up remedial class was conducted to clear up the confusion and to assist them to acquire necessary and basic skills and knowledge of vector analysis, viz., free-body diagram, finding vertical and horizontal components of vectors, equilibrium conditions as well application of Newton's Second law of motion. With this skill, they were introduced to deriving equations to calculate the acceleration of the objects and the tension of the wire connecting them (mathematical skills). A post-test was thereafter administered and the results indicated a great improvement (more than 70%) in the vector analysis and mathematical application of vectors in problem solving. Follow-up interviews indicated deficiencies and confusion from their previous learning although some students (about 30% of the 70%) indicated they need to be taught the concept first before the test. Their reasoning was that they forgot the concept as they didn't understand it previously and or they had previously learnt it to pass before.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Dr MP Rankhumise
RankhumiseMP@tut.ac.za
Tshwane University of Technology

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Physics of Condensed Matter and Materials 1 / 386

Spin induced switching in gadolinium functionalized multiwall carbon nanotube nanocomposites

Author: Siphephile Ncube[1]

[1] *University of the Witwatersrand*

Corresponding Author: siphephilen@yahoo.com

We report on the switching behaviour in Multi walled carbon nanotubes (MWNTs) functionalized with a gadolimium (Gd) supramolecular complex. The nanocomposite is synthesized from a modified covalent functionalization method to enhance the strength of interaction between the CNT and the magnetic supramolecules. The structural and magnetic properties of Gd-DPTA functionalized MWNTs are exploited using various techniques namely High Resolution TEM, Magnetic force microscopy, Raman spectroscopy and SQUID magnetometry. The thermal variation of the inverse suceptibility indicates that the nanocomposite exhibits an antiferromagnetic exchange interaction. Most importantly from the low temperature transport studies at 300 mK in devices fabricated from networks of Gd-functionalized MWNTs, it was found that spin induced switching is observed which is attributed to co-tunneling in the coulomb blockade regime. The strength of the spin switching was found to be dependent on the excitation current and increased from 3 to 10% at 10 μA and 1 μA respectively. We also observed anisotropy in the switching fields as well as multiple switching events similar to nonlocal four probe measurements previously observed in single walled carbon nanotube networks. This work has potential for application in the fabrication of data storage and high speed electronic devices.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Somnath Bhattacharyya

somnath.bhattacharyya@wits.ac.za

University of the Witwatersrand

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 24 / **387**

The role of the pre-exponential factor in the segregation profiles of Cu(111)-SnSb and Cu(100)-SnSb ternary alloys

Author: Joseph Asante[1]

Co-author: Wiets Roos [2]

[1] *Tshwane University of Technology*

[2] *University of the Free State*

Corresponding Author: asantejko@tut.ac.za

A Cu(111) and Cu(100) were thermally doped with the same concentrations of Sn (0.14 at%) and Sb (0.12 at%) in both crystals. Auger electron spectroscopy was used to measure the segregation profiles. The segregation parameters of Sn and Sb were extracted by comparing simulated profiles with the experimental data.
The segregation profiles in the two crystals were compared and it was found that the profiles of both Sn and Sb in Cu(111) shifts to lower temperatures than those in Cu(100). The quantified segregation parameters were used to explain the shift. It is argued that changes in the pre-exponential diffusion factors, rather than the activation energies, is the main contributing parameter.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Poster Session 2 - Board: 25 / **388**

Structural and thermodynamic properties of Zr-Nb-Co

Author: Magoja Malebati[1]

Co-authors: Hasani Chauke [2]; Phuti Ngoepe [2]

[1] *student*

[2] *member*

Corresponding Author: martinusm9@gmail.com

More advanced Zr-based alloys are being developed for the more severe operating conditions such as higher burn-up and increased operation temperature, this is due to their good resistance to corrosion and high melting point. In this work, density functional theory have been used to investigate the structural and thermodynamic properties of Zr-Nb-Co system at various concentrations. We used the virtual crystal approximation to introduce small Co content on different Zr-Nb composition, Zr₇₈Nb₂₂, Zr₉₇Nb₃, Zr_{98.1}Nb₂,

Zr₉₉Nb₁, We found that the increase in Co concentration enhances the stability of the compound with the Zr₇₈Nb₂₂ being the most preferred composition, and the alloy is stable only at a small Co concentration of about 3%. The structure were also confirmed using XRD patterns. we also found that the Zr₇₈Nb<sub>17<sub>Co₃ structure is stable above 900K

**Apply to be
 considered for a student
   award (Yes / No)?:**

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

MSc

**Main supervisor (name and email)
and his / her institution:**

H. R. Chauke, Hr.Chauke@ul.ac.za, University of Limpopo

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Nuclear, Particle and Radiation Physics 2 / 389

The search for new bosons at the Large Hadron Collider

Author: Bruce Mellado[1]

[1] *University of the Witwatersrand*

Corresponding Author: bmellado@mail.cern.ch

With the discovery of a Higgs boson at the Large Hadron Collider (LHC) new opportunities have open for the field of collider physics. The study of the couplings of this Higgs boson to other particles and the search for new bosons have become a focus. Based on features of the data collected by experiments at the LHC during Run 1 (until the end of 2012) the hypothesis of a new boson was formulated and the compatibility with the data was estimated. In this hypothesis the new boson would have a mass around 270 GeV and would decay in to the Higgs boson and another scalar, referred to as S, among other decays. This leads to a number of predictions that will be summarized. The compatibility of the hypothesis with new data will also be discussed.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Poster Session 2 - Board: 26 / **390**

Structural, Morphological and Confocal Raman Spectroscopy characterization of titanium dioxide nanotubes on functional substrates

Author: Simcelile Zinya[1]

Co-author: Raymond Tazawa [1]

[1] *FHIT*

Titanium dioxide nanotubes (TNTs) arrays were grown on the titanium film layers sputter coated on a conductive glass substrate for the development of photoelectrodes for dye-sensitized solar cell application. Highly cohesive titanium films were deposited on functional substrates (FS) using RF sputtering technique at a sputtering power of 150W, operating pressure of 39 mbar and at a deposition temperature of 200°C for 4 hours to obtain a thickness of 10 μm under an inert argon atmosphere. Subsequently, the RF sputtered titanium films were anodized with ammonium fluoride/glycerol electrolyte solution at room temperature at 60 V for 72 hours. The resulting TNTs on functional substrates (TNTs-FS) were subjected to thermal treatment at 350°C, 450°C, 550°C and 650°C for 3 hours under a nitrogen atmosphere. The as prepared and thermally treated TNTs-FS were characterized by SEM, XRD, EDX and Confocal Raman Spectroscopy (CRS). CRS Large Area Scan (LAS) and Depth profiling (DP) were employed to study and evaluate the crystallinity phase distribution of TNTs-FS thermally treated at different temperatures. CRS LAS in the XY direction of TNTs-FS has revealed the presence of differently crystallized Anatase phases of TiO2 with Raman vibrational modes of 159.38 cm-1 (Eg), 208. 37 cm-1 (Eg), 399.67 cm-1 (B1g), 514.25 cm-1 (A1g) and 641.58 cm-1 (Eg) for the samples annealed at 350°C. The effect of annealing temperature on TiO2 phase evolution was meticulously evaluated using CRS for TNTs-FS for the samples annealed at 450°C, 550°C, and 650°C and will be presented in the final paper.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Professor Edson Meyer.
EMeyer@ufh.ac.za
University of Fort Hare

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Theoretical and Computational Physics 1 / 391

Noncentral r-priors

Author: Michiel De Kock[1]

Co-author: Hans Eggers [1]

[1] *Stellenbosch University*

Corresponding Author: mbdekock@sun.ac.za

While the Bayesian Information Criterion (BIC) and Akaike
Information Criterion (AIC) are powerful tools for model selection in linear regression, they can fail dramatically in low signal to noise situations. We shall argue that this is caused by the implicit choice of priors underlying these criteria. Analysing these priors in the context of an expanded model-plus-noise space, we design more appropriate priors and a derive from them a new "Noncentral Information Criterion" which inherits the good properties of the BIC and AIC but performs better than both.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Nuclear, Particle and Radiation Physics 1 / 392

Ancillary detectors at the K600 magnetic spectrometer

Authors: Frederick David Smit[1]; Kevin Li[2]; Luna Pellegri[3]; Paul Papka[4]; Philip Adsley[5]; Retief Neveling[1]; Vicente Pesudo[6]; Zaid Dyers[1]

[1] *iThemba LABS*

[2] *Stellenbosch University, iThemba Labs*

[3] *University of Witwatersrand and iThemba LABs*

[4] *Stellenbosch University*

[5] *University of Stellenbosch/iThemba LABS*

[6] *UWC*

Coincidence measurement capability was implemented at the K600 spectrometer in order to achieve higher selectivity and to obtain more information in nuclear structure studies. This presentation gives an overview of the technical solutions and performance of the ancillary detectors available at the K600 spectrometer. Dedicated electronics were installed allowing up to 160 detector channels to be coupled with the existing VME based data acquisition system. A new scattering chamber was designed for zero degrees and small angle measurements. This chamber was built to accommodate compact charged particle detector arrangements with minimum amount of material to allow simultaneous gamma-ray detection. The chamber is now operational at large angles (17-41 degrees) with sliding seal equivalent mechanism to operate optimally angle changes under vacuum conditions. The CAKE array (Coincidence Array for K600 Experiments) was implemented successfully and is now operated routinely at zero degrees and finite spectrometer angles. The silicon detectors are being optimised with a redesign of the segmentation for improved angular distribution measurements. The BaGeL (Ball of Germanium and LaBr3) array was implemented in the year 2016. Two measurements were performed successfully using 8 HPGe clovers and two large volume LaBr3 detectors. The integration of the GAMKA spectrometer is anticipated with various detector arrangements combining up to 17 HPGe clover detectors and 23 large volume LaBr3 detectors.

Summary:

An overview of the ancillary detection setup at the K600 spectrometer is given with emphasis on performance and technical details of the CAKE and BaGeL arrays. Recent results are presented illustrating the enhanced sensitivity of the experimental setup. Future planned developments are also discussed.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Theoretical and Computational Physics 1 / 393

Systematic model construction by squared series expansions

Author: Antonie de Beer[1]

Co-authors: Hans Eggers [2]; Michiel De Kock [2]

[1] *Student*

[2] *Stellenbosch University*

Corresponding Author: antoniejdb@gmail.com

In data analysis it is often difficult to understand which parameters in a model are relevant and which are not. The number of parameters must also be optimised in a systematic way.

In the Bayesian framework, the optimal set of parameters is determined by maximising the model evidence (eg via the Savage-Dickey density ratio), which is made up of a likelihood and a prior probability.

Commonly encountered orthogonal series expansions are, however, necessarily oscillatory and hence cannot describe positive definite likelihood probabilities. Expanding square roots of the likelihood permits us to achieve positivity. The argument for using square roots is reinforced by the constraints to the model by the Savage-Dickey density ratio and the Jeffreys prior.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Msc

**Main supervisor (name and email)
and his / her institution**:

Prof. Hans Eggers
eggers@physics.sun.ac.za
Stellenbosch University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 79 / **394**

Preparation and evaluation of NIR up-converting ZnTiO3:Er3+ nanophosphor prepared by conventional solid state reaction.

Author: Sefako John Mofokeng[1]

Co-authors: Bakang Moses Mothudi [1]; Luyanda Lunga Noto [2]; Mokhotjwa Simon Dhlamini [1]; Odirileng Martin Ntwaeaborwa [3]

[1] *University of South Africa*

[2] *University of Free State (Student)*

[3] *University of the Witwatersrand*

Corresponding Author: sefakojmofokeng@gmail.com

Up-converting luminescent nanoparticles are promising and advantageous alternative to possess anti-Stokes shift emission by up-converting near infrared (NIR) excitation light (980 nm) to emit visible light [1, 2]. In the present work, ZnTiO3 nanophosphor doped with different concentrations of Er3+ ions were synthesized via a conventional solid state reaction method using metal oxides as precursors. The crystal structure, particle morphology, optical and up-conversion luminescence properties of ZnTiO3:Er3+ nanophosphor were analyzed using various techniques such as X-ray diffraction (XRD), scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDS) UV-Vis spectroscopy and photoluminecsent (PL) spectroscopy, respectively. The X-ray diffraction (XRD) patterns confirmed crystallization of hexagonal ZnTiO3 phase. In addition, photoluminescence properties showed green (2H11/2, 4S3/2 ⟶ 4I15/2 transitions) and red (4F9/2 ⟶ 4I15/2 transition) emissions from Er3+ when excited in the NIR region with an excitation wavelength of 980 nm diode-laser. The interaction mechanisms involved in the up-conversion process of ZnTiO3:Er3+ nanophosphor is discussed with the help of an energy-level schematic.

Key words: Nano-phosphor, up-conversion luminescence, Er3+ ions.

References
[1] L. Lei, J. Zhu, G. Xia, H. Feng, H. Zhang and Y. Han. Talanta 162 (2017) 339–344.
[2] E. Palo, M. Tuomisto, I. Hyppanen, H.C. Swart, J. Holsa, T. Soukka and M. Lastusaari. Journal of Luminescence 185 (2017) 125–131.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof Mokhotjwa Simon Dhlamini

Email address:dhlamms@unisa.ac.za

Institution: University of South Africa

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Nuclear, Particle and Radiation Physics 1 / 395

Feasibility of Nuclear Plasma Interaction studies with the Activation Techniques

Author: Nogwanya Thembalethu[1]

Co-authors: Bleue Darren [2]; Wiedeking Mathis [3]

[1] *UWC*

[2] *Lawrence Livermore National Laboratory*

[3] *iThemba*

Electron-mediated nuclear plasma interactions (NPIs), such as Nuclear Excitation by Electron Capture (NEEC) or Transition (NEET), may have significant impact on nuclear cross sections in High Energy Density Plasmas (HEDPs). These HEDP environments are found in the cosmos where nucleosynthesis takes place. Attempts have failed so far in measuring the NEEC process [1], while

NEET has recently been observed experimentally [2]. NEEC, NPIs have not been observed due to the narrowness of nuclear transitions ($\Gamma \leq 1$eV). The NPIs may occur on highly excited nuclear states in the quasi-continuum which is populated in nuclear reactions prior to their decay by spontaneous γ-ray emission. Direct observation of NPIs are hindered by the lack of a clear signature of the effect in HEDP environments. Hence, a new signature [3] for NPIs on highly excited nuclei will be tested by investigating isomeric to ground state feeding from the quasi-continuum region. An experiment was performed using the reactions 197 Au(13 C, 12 C) 198 Au and 197 Au(13 C, 12 C2n) 196 Au at Lawrence Berkeley National Laboratory in inverse kinematics with a 197 Au beam of 8.5 MeV/u energy. The activated foils were counted at the low-background counting facility of Lawrence Livermore National Laboratory. I will discuss several measurements with different target configurations to investigate the feasibility of NPI studies.

References

[1] P. Morel et al., Nucl. Phys. A 746, 608c (2004)
[2] S. Kishimoto et al., Phys. Lett. 85 , 1831 (2000)
[3] D. L. Bleuel et al., Plasma and Fusion Research 11, 3401075 (2016)

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Msc

**Main supervisor (name and email)
and his / her institution**:

Dr Mathis Wiedeking wiedeking@tlabs.ac.za at iThemba LABS

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 69 / **396**

AIR CONDITIONING PERFORMANCE MONITORING IMPROVEMENT VIA REGRESSION MODELLING

Author: GLORY BANTAN MAFOR[1]

Co-authors: Michael Simon [2]; Stephen Loh Tangwe [3]

[1] *UNIVERSITY OF FORT HARE*

[2] *FHIT*

[3] *Fort Hare Institute of Technology, University of Fort Hare*

Corresponding Author: bantanmaforglory@gmail.com

As a result of system operation complexity owing to the huge number of dynamic factors influencing the system's operation, air conditioning (AC) performance monitoring has been a fastidious task. These influencing factors cut across the environmental, human and system behavioural variation. Trying to monitor performance based on predictors from one major influencer will compromise monitoring accuracy. This paper elaborates on the development of four multiple linear regression models that can be used to monitor the heating and cooling performance of a domestic split-type AC. The predictors used cut across the three main performance influencers and include performance ratio (PR), ambient temperature and room temperature. These models correlate system heating and cooling thermodynamic (COPc and COPh) and electrical (energy) performance to afore mentioned predictors. Data used to develop these models was obtained from an experimental set up installed in a residential home in Alice, Eastern Cape Province, South Africa. The developed models had correlation and determination coefficient in the range 0.90 – 0.95, thus indicating a strong connexion

between the predictors, modelled and actual responses. This goes to show that afore mentioned predictors do not only greatly influence system performance but can also be used to improve on the accuracy of monitoring and predicting the performance of a domestic split-type AC with an eminent degree of accuracy.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Dr. Michael Simon
msimon@ufh.ac.za
Institute of Technology
University of Fort Hare

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 27 / **397**

The study on the synthesis and deposition parameters of metal doped-ZnO thin films for applications in in inverted organic solar cells

Author: Luleka Menzi[1]

Co-authors: Bakang Mothudi [1]; Pontsho Mbule [1]

[1] *Unisa*

Corresponding Author: stretchmenzi@gmail.com

This study focuses on aluminum doped-zinc oxide (AZO) nanoparticles which have been synthesized using the sol-gel method at room temperature. The gel was a resultant of a zinc acetate dehydrate precursor, absolute ethanol as a solvent, dimethylsulfoxide (DMSO) as a stabilizing ligand and tetramethylammonium hydroxide (TMAH, 25WT%) to initiate ZnO nanoparticle formation. The zinc acetate dehydrate mass was varied from 1g to 6g and the dopant concentration was varied from 1 to 5 mol%. . The products were spin coated onto glass substrates at different spin rotations, from 500rpm to 2500rpm. AZO thin films, showed crystallite size in the range of 2 to 5nm with spherical shape and 2θ = 34.34o corresponding to (002) plane of Hexagonal wurtzite structure of ZnO. Spin coating does not produce uniformly deposited films so the defects are expected to change with the deposition speeds. AZO thin films showed higher transparency greater than 80% in the visible region while the electrical resistivity can be expected to be 10-3 Ωcm. The AZO thin films were further characterized for elemental composition using energy dispersive spectroscopy (EDS). Film thickness, refractive index and dielectric constants were determined using spectroscopic ellipsometer. Hall measurement system was used to measure the sheet resistance, carrier concentration and mobility of AZO thin films.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof BM Mothudi mothubm@unisa.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 28 / **398**

STRUCTURAL AND OPTICAL PROPERTIES OF BIOSYNTHESIZED ZINC OXIDE NANOPARTICLES

Author: Nolufundo Sintwa[1]

Co-authors: Bakang Mothudi [1]; M Maaza [2]; Margaret Yankey [1]

[1] *Unisa*

[2] *iThemba Labs*

ZnO nanoparticles were successfully synthesized using the eco-friendly green method, where Zinc nitrate was reacted with the extract of Callistemon Viminalis' (Bottle Brush). The structural and optical properties were determined using X-Ray diffraction and Photoluminescence (PL) spectroscopy. The XRD showed that zincite was synthesized having a hexagonal structure and a room temperature PL was used to determine the luminescence, strong emission peaks were observed at 377,6nm, 491,8nm and 533,6nm. These emissions show that ZnO is a suitable material to be used for luminescence.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof M Maaza likmaaz@gmail.com iThemba Labs

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 29 / **399**

Bias-enhanced nucleation and growth for improving the opto-mechanical properties of diamond-like carbon films

Author: wilfred mbiombi[1]

Co-authors: Daniel Wamwangi [1]; Mathe Bhekumusa [1]; david billing [1]; rudolph erasnus [1]

[1] *wits*

Amorphous C/diamond-like thin films have been prepared by rf plasma enhanced vapour deposition from a CH4/Ar gas mixture. Infrared and optical-ultraviolet absorption characteristics are reported and used to characterize the bonding and optical properties of these films. The relationship between

the optical band gap, dc self-bias and the hydrogen content is investigated. It is found that the hydrogen content is not directly related to the optical band gap. In addition, the tensile Young's modulus and the torsion shear modulus of the DLC films are measured using Brillouin light scattering and correlated with the possible growth of polymeric carbon chains and increased clustering.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Bhekumusa Mathe
Bhekumusa.Mathe@wits.ac.za
University of WITS

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Physics of Condensed Matter and Materials 1 / 400

Effect of Tb3+ concentration on the structure and photoluminescence of Zn0.5Mg0.5Al2O4:x% Tb3+ (0 < x ≤ 1) nanophosphor synthesized by citrate sol-gel method

Author: Setumo Victor Motloung[1]

Co-authors: Lehlohonolo Koao [2]; Mbonge Sithole [3]; Tshwafo Motaung [4]

[1] *SMU*

[2] *UFS (Qwa Qwa Campus)*

[3] *Sefako Makgatho Health Science University*

[4] *University of Zululand*

The un-doped zinc magnesium aluminate (Zn0.5Mg0.5Al2O4) and Tb3+ doped nanophosphor were prepared by the citrate sol-gel method at low temperature (⊠ 80 ℃) and thermally treated at 1000 ℃ for 3 hrs. The effect of varying the x% Tb3+ in the range of (0 < x ≤ 1) on the structure, morphology and optical properties of the Zn0.5Mg0.5Al2O4 nanophosphors were investigated. The Energy dispersive x-ray spectroscopy (EDS) analysis confirmed the presence of the expected elements (Zn, Mg, Al, O and Tb). The x-ray diffraction (XRD) analysis confirmed that the nano-powders crystallized into the mixed cubic spinel structures of Zn0.5Al2O4 and Mg0.5Al2O4. Tb3+ doping influenced crystallinity of the prepared powder samples. The crystallite size and particle morphology were affected by variation in the Tb3+ concentration. Different emission peaks located around 390, 490, 546, 584 and 620 nm from Tb3+ transitions were observed. The most intense emission peak was found at 546 nm, which is ascribed to 4D4 ⟶ 7F5 transition from Tb3+. Increasing the Tb3+ concentration up-to x = 0.4% lead to luminescence intensity enhancement, while further increase of Tb3+ concentration lead to concentration quenching. CIE colour coordinates confirmed that the emission colour can be tuned from blueish ⟶ greenish by varying the Tb3+ concentration.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 30 / **401**

Luminescent, Structural and Morphological studies of a green-emitting BaB8O13: Ce3+ phosphors

Author: Mantwa Annah Lephoto[1]

Co-authors: Kamohelo George Tshabalala [1]; Odireleng Martin Ntwaeaborwa [2]; Selepe Joel Motloung [1]

[1] *University of the Free State (QwaQwa campus), Private Bag X13, Phuthaditjhaba, 9866, South Africa*

[2] *University of the Witwatersrand, Private Bag 3, Wits, 2050, South Africa*

Corresponding Author: dunkie86@gmail.com

Key words: Combustion method; William-Hall; Band-gap; Photoluminescence; CIE.
Abstract: BaB8O13: Ce3+ powder phosphors were synthesized by solution combustion method for general lighting applications. X-ray diffraction, Fourier transform spectroscopy, Scanning electron microscopy, UV-visible spectroscopy and photoluminescence studies were used to characterize the prepared powder phosphors. Powder X-ray spectra confirmed the formation of orthorhombic structure of BaB8O13 with cell parameters a = 8.550 Å, b = 17.350 Å and c = 13.211 Å according to JCPDS file no: 20-0097 [1]. The estimated crystallite sizes of the powder phosphors from Scherrer's equation and Hall-Williamson's plot were in the nanometre scale. Scanning electron microscopy micrographs showed that the particles with irregular shapes were agglomerated together. The bands in the Fourier transform infrared spectra in the range 650 − 1600 cm-1 also confirms the formation of the desired powder phosphor. The estimated bandgap of the powder phosphors from Kubelka - Munk was reduced with the increase in concentration of Ce3+. The BaB8O13: Ce3+ powder phosphors showed emission at around 515 nm ascribed to 5d1 − 4f1 transition of Ce3+ after UV excitation of 270 nm using a monochromatized xenon lamp. A standard CIE diagram derived from relative emissions from the powder phosphors suggested a unique emission concentrated in the green region, thus the phosphor serve as a potential source of green light emitting devices [1].
Reference: 1] E, Erdogomus, E. Orkmaz and V.E. Kafadar, J. Appl. Spectrosc, 80, 2014, 952-956

Summary:

N/A

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Ntwaeaborwa Martin
ntwaeab@gmail.com
Witwatersrand university
School of physics, University of the Witwatersrand, Private Bag 3, Wits, 2050, South Africa

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 2 - Board: 31 / **402**

Dopping effect on tin oxide nanostructures and gas sensing ability

Author: Charles Thulani Thethwayo[1]

Co-authors: Amanda Sefage [1]; Osmen Ndwandwe [1]; Philip Jili [1]; Prince Mkwae [1]

[1] *University of Zululand*

Corresponding Author: zhumane@gmail.com

tin oxide (SnO₂) nanostructures were synthesized using chemical bath method and DC magnetron sputtering. SnO₂ oxide nanostructures were deposited at different temperatures (300 ^oC, 400 ^oC, and 500 ⁰C. XRD results shows that as the temperature increases also the cystalinity increases. SEM results also show that particle sizes increase with the increase in temperature. EDS show that the ratio of tin to oxygen is as expected to be. More studies will be carried out on the samples as to show the effect of doping on gas sensing ability of SnO₂. It was found that the temperature has the effect on nanoparticle sizes and their crystalinity. we bilieve doping nanoparticle will enhance the gassing sensitivity of Tin Oxide nanostructure.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof OM ndwandwe, ndwandweO@unizulu.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Poster Session 2 - Board: 32 / **403**

Structural characterization of polyaniline thin films doped by Ag+ ion implantation

Author: Jimmy Mokoena[1]

Co-authors: Mandla Msimanga [2]; Mmantsae Diale [3]; Nolufefe Ndzane [4]

[1] *Tshwane University of technology*

[2] *Tshwane University of Technology*

[3] *University of Pretoria*

[4] *none*

Corresponding Author: jemmynitro705@gmail.com

Polymeric thin films in electronic device applications are becoming more commonplace due to relatively low production and material cost when compared to conventional semiconductors.
Polyaniline is one of the most widely studied conducting polymers and organic semiconductor due to its rich chemistry and relative stability.
Current research efforts into polymer based photo-voltaic and radiation sensorsaregeared towards

tailoring material properties of the polymers to improve their quantum efficiency to at least match that of silicon based detectors.
This contribution presents results of a study carried out to establish the relationship between film structure of conjugate polyaniline films spin-coated onto silicon substrates and Ag+ ion implantation dose.
The polyaniline (PANI) films were prepared by dissolving of Emeraldine Base (EB-PANI) in 1-Methyl-2-Pyrrolidinone and spin coating onto silicon substrates. Film characterization was carried out using SEM, RBS, XRD and Raman Spectroscopy before and after Ag+ ion implantation to different doses.

**Apply to be
 considered for a student
   award (Yes / No)?**:

yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Prof M Msimanga
Email:msimangam@tut.ac.za
Tshwane University of Technology

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

yes

Space Science / 404

Midlatitude post sunset plasma bubbles during 11 April 2001 intense storm

Author: Zama Thobeka Katamzi-Joseph[1]

Co-author: John Bosco Habarulema [1]

[1] *South African National Space Agency*

Corresponding Author: zkatamzi@sansa.org.za

First observation of plasma bubbles over the European middle latitudes during an intense storm of 11 April 2001. The plasma bubbles are observed in Global Navigation Satellite System (GNSS) total electron content (TEC) measurements during the interplanetary magnetic field (IMF) Bz southward turning and confirmed with in-situ plasma density measurements from the Defense Meteorological Satellite Program (DMSP) satellites. The results show that the plasma bubbles originate from the equatorial ionospheric anomaly region and migrate poleward at virtual speeds of 400 m/s. During the time of occurrence of the plasma bubbles, TEC and ionosonde F2-region peak density measurements were enhanced compared to the 5 quietest days of the month. Evidence from ionosonde F2-region height measurements indicate an upward plasma motion while the interplanetary electric field (IEF) Ey was enhanced. This was found to suggest that the possible mechanism for the enhancement middle latitude plasma and subsequent plasma bubble occurrence was the eastward penetration electric field associated with IMF Bz southward turning.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 33 / **405**

Characterization of AlxGa1-xAs by FTIR Spectroscopy

Author: Nobom Hashe[1]

Co-authors: Ettienne Minnaar [1]; William Goosen [1]

[1] *Nelson Mandela Metropolitan University*

Corresponding Author: nobom.hashe@nmmu.ac.za

The ternary semiconductor AlxGa1-xAs alloy finds many applications in the electronics industry. With very nearly the same lattice constant as GaAs, it is used as a barrier material in GaAs based heterostructure devices, where the AlGaAs layer confines the electrons to a gallium arsenide region. An example of an AlGaAs/GaAs device is a quantum well infrared photodetector. Alloys are grown on GaAs by metalorganic vapour phase deposition, and different properties of the alloy can be obtained by varying the Al content in AlxGa1-xAs. It is therefore important to characterize the alloy to establish its properties as a function of Al content.
A total of 5 AlxGa1-xAs samples with different Al contents were characterized by Fourier Transform Infrared spectroscopy (FTIR) in the reflectance mode. A Bruker 80V FTIR/Raman system, fitted with a horizontal stage sample holder, enabling near-normal incidence of incident radiation, was used to measure the reflectance of the samples. 50 Scans of each sample were obtained at a resolution of 8 cm-1 and all measurements were done under vacuum. Layer thicknesses could be calculated from interference fringes in the reflectance spectra of the various samples. The results thus obtained by FTIR were compared to scanning electron microscopy (SEM) analyses. Preliminary results indicated that the layer thicknesses varied between 3.2 and 6.1 micron, which are in agreement with values supplied by the epilayer crystal growers. Results will be presented and discussed.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 2 - Board: 34 / **406**

Predicting the Mo dopant induced electrical levels in Ge

Author: Emmanuel Igumbor[1]

Co-authors: Edwin Mapasha [1]; Okikiola Olaniyan [1]; Walter Meyer [1]

[1] *University of Pretoria*

Corresponding Author: elgumuk@gmail.com

In this report, an ab initio calculation results of the Mo dopant induced levels in Ge were presented. The density functional theory (DFT) with the Heyd, Scuseria, and Ernzerhof (HSE06) hybrid functional was used to calculate the minimum total energies for the Mo vacancy-complexes of Ge (V_{Ge} Mo_{Ge}) and Mo substitution in Ge (Mo_{Ge}). The formation energies of the first nearest neighbour (N1), second nearest neighbour (N2) and third nearest neighbour (N3) configurations for the V_{Ge} Mo_{Ge} as well as the Mo_{Ge} were obtained for charge states -2, -1, 0, +1, and +2. The calculated formation energies for the V_{Ge} Mo_{Ge} resulted to positive binding energies for the N1, N2 and N3 configurations. The N2 configuration is the most energetically favourable with a formation and binding energies of −0.14 and 0.06 eV, respectively. The Mo_{Ge} has a formation energy of −2.99 eV and induced electrical level which exhibits a negative-U ordering within the band gap of Ge. The (+1/-1) transition charge states induced by the Mo_{Ge} is a deep level lying at E_V + 0.31 eV.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Poster Session 2 - Board: 35 / **407**

Analysis of temperature dependent I-V characteristics of Pd/n-4HSiC Schottky barrier diodes and the determination of the Richardson constant in a wide temperature range

Author: Elifas Gora[1]

Co-authors: Albert Chawanda [2]; Cloud Nyamhere [1]; Danie Auret [2]; Helga Danga [3]; Shandirai Tunhuma [2]

[1] *Midlands state university*

[2] *University of Pretoria*

[3] *MSc Student*

Corresponding Author: malven.tunhuma@up.ac.za

The current-voltage characteristics of Pd/n-4H-SiC Schottky barrier diodes in the 300-800 K temperature range have been analysed . Barrier height and ideality factor were found to be highly temperature dependent. Barrier height increases whilst ideality factor decreases with an increase in temperature and the conventional activation energy plot showed some deviation from linearity. This was attributed to barrier in-homogeneities at the metal semiconductor interface which resulted in a distribution of barrier heights at the interface. From the modified Richardson plot, the Richardson constant, A^{**} was found to be 155 Acmˆ-2Kˆ-2 in the 300-525 K range and 87 A cmˆ-2Kˆ-2 in the 550-800 K temperature range.

**Apply to be
 considered for a student
   award (Yes / No)?:**

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

PhD

**Main supervisor (name and email)
and his / her institution:**

A Chawanda chawandaa@msu.ac.zw Midlands State University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Poster Session 1 - Board: 38 / **408**

Modelling the JVLA antenna primary beams with characteristic basis functions

Author: Iheanetu kelachukwu[1]

[1] *Rhodes University*

Corresponding Author: kelahard@yahoo.com

Accurate modeling of the antenna primary beam response is important in many wireless applications, but is particularly crucial for the next generation of radio telescopes, since they offer unprecedented levels of sensitivity, at which even the most subtle instrumental effects become important. Electromagnetic and optical simulations which has often been used to model it can only provide a first-order approximation; real-life primary beam patterns differ from this due to various subtle effects such as mechanical deformation, etc. Ideally, a parameterized model is required, so that these effects can be calibrated for in a closed-loop manner. Instances of actual patterns can be measured through a process known as holography, but this is subject to noise, radio frequency interference, and other measurement effects. We present a set of holography measurements for a subset of dishes of the Karl G. Jansky Very Large Array telescope (JVLA US), and discuss the problem of using these measurements to derive parameterized models of the primary beam. We show that the beams exhibit complicated frequency behavior due to standing waves in the optics, particularly in the polarization terms. We discuss the potential application of a technique called characteristic basis function patterns (CBFPs) to these data, which offers the possibility of deriving a parameterized model that can accommodate subtle variations in the beam pattern.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Oleg Smirnov, osmirnov@gmail.com, Rhodes University
Julien Girard, jgirard@ska.ac.za, AIM/CEA, Université Paris Diderot (Paris 7)

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Theoretical and Computational Physics 1 / **409**

Power series expansion of the Jost function on the complex angular momentum plane.

Author: Tshegofatso Tshipi[1]

[1] *University of Pretoria*

Corresponding Author: t.tshipi@gmail.com

The aim of this research is to develop a method for expanding the Jost functions as a Taylor-type power series on the complex angular momentum plane. From this method in conjunction with the Watson transformation, we were able to express the scattering amplitude as a sum of the background and pole terms, furthermore, this method proposes a way of evaluating, numerically, the pole term. To demonstrate how this method may be applied, we considered the Born approximation. We found out that the developed method improved the Born approximation at large scattering angles. Therefore, this method is useful when the differential cross section of the background term fails to converge to that of the exact differential cross section at large scattering angles.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Name : Prof. Sergei Rakitianski
email : Sergei.Rakitianski@up.ac.za
Institution : University of Pretoria

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Astrophysics / 410

Discretization of an extended solar system

Author: Pieter Wagener[1]

[1] *University of Fort Hare*

Corresponding Author: pcwagener@axxess.co.za

A formula derived from a theory of gravitation is applied to periods, or distances from the sun, of orbiting bodies of the solar system extending to beyond the Kuiper belt and into the Van Oort Cloud. It includes the periodic comets and asteroids. The formula gives discrete distances for 38 selected solar bodies, as well as discrete periods of the major comets, within an average relative deviation of 1.8\% from the observed values.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Poster Session 1 - Board: 70 / **411**

Discovery of microdiamonds and disordered graphite by Raman spectroscopy in a mullite-magnetite-silica glass melt rock of impact origin, Gilf Kebir Plateau, SW Egypt

Author: Marco Andreoli[1]

Co-author: Rudolph Erasmus [1]

[1] *University of the Witwatersrand*

Corresponding Author: rudolph.erasmus@wits.ac.za

Libyan Desert Glass (LDG), discovered in 1933, is a pale green rock of almost pure silica glass loosely scattered over approximately 2500 square kilometres near the Egypt-Libyan border. It has been established that LDG originated during the explosion of an extra-terrestrial agent about 29 million years ago. In 2013 it was reported that a black, diamond-rich, rock fragment discovered in the LDG area years earlier, was a piece of comet, the first such cometary fragment to be found and identified. This cometary fragment was named "Hypatia". Separate from this discovery, a mullite-magnetite-glass rock sample was collected from an area close to the LDG strewn field in 2007. This melt rock has a composition and mineralogy unreported thus far for any terrestrial magmatic rock. Phase diagrams of the SiO2-Al2O3-FeO-Fe2O3 system suggests a temperature of ˜1600 oC is required to produce the observed composition, consistent with an extra-terrestrial origin, but an absence of high pressure phases thus far seems to indicate against an origin by extra-terrestrial impact. In this presentation we show very recent evidence obtained via Raman spectroscopy of cubic diamond and disordered carbon present on a number of small, irregular dark streaks present in a light grey dull matrix of surrounding material. This discovery of ˜2 micron-sized diamonds present in the mullite-magnetite rock is difficult to explain by a terrestrial process and provides new evidence for the extra-terrestrial origin of the mullite-magnetite rock and its potential association with the LDG and Hypatia.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Astrophysics / 412

Bayesian r-priors: fixing the problems inherent in traditional best fit techniques

Authors: Hans Eggers[1]; Michiel De Kock[1]

Co-author: Riyaadh Jamodien [2]

[1] *Stellenbosch University*

[2] *SUN*

Corresponding Author: 16113004@sun.ac.za

A primary goal of data analysis is to determine what mathematical model can best describe how the data came about. Often, however, there are competing explanations in the form of different parametrisations, so that <it>model comparison</it> becomes necessary.

Within the Bayesian framework, model comparison is effected by means of the <it>evidence</it> and the <it>posterior odds</it> as well as information criteria inspired by information theory. These quantities are used to compare hypotheses to find the one closest to the physical model.

Starting from the usual minimum-chisquared fitting of data by linear models, we show how the evidence is calculated and why chisquared is an inadequate criterion. This leads us to introduce so-called <it>r-priors</it> which generalise the Zellner-Siow priors and Liang's g-prior to explicit spherically symmetric space.

We show by example how r-priors compare to, and improve on, both the traditional chisquared method and the older Bayesian methods.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

Professor Hans Eggers
eggers[att]physics[dott]sun[dott]ac[dott]za
Stellenbosch University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Nuclear, Particle and Radiation Physics 1 / 413

Radiation Safety Calculations for iThemba LABS ACE Isotopes facility.

Author: Nkanyiso Mantengu[1]

Co-author: Robert Bark [1]

[1] *iThemba LABS*

Corresponding Author: nrmantengu@tlabs.ac.za

The design of iThemba LABS Accelerator Centre for Exotic (ACE) Isotopes facility was proposed to have four beam-lines
feeding the beam to two production vaults, with each vault having two production stations. The plan is to simultaneously operate one production station in both production vaults, meaning that only two opposite beam-lines will be delivering the beam at a time, with each of the two beam-lines feeding 70 MeV energy proton-beam of up to 350 μA current.

Two Faraday cups will be simultaneously used to stop 50 μA (standard beam current) proton beams during the optimization of beam-lines parameters.

The whole ACE operating system will be accompanied by an interlock system that will switch off the parameters of the cyclotron, e.g. the RF, and insert a Faraday cup in the axial injection line in case the beam is accidentally stopped in the beam-line. Moreover, less than 5% beam loss is expected to occur in the cyclotron. Beam-pipes of 150 mm diameter were proposed, therefore, the beam losses in beam-lines are not expected to be significant. Radiation resulting from beam loss in the cyclotron (35 μA at most) will, to a large extent, be shielded by the magnet of the cyclotron. The magnet shielding of the radiation caused by beam loss inside the cyclotron is better in the vertical direction. Therefore, radiation that will make it through the cyclotron vault floor to the basement is not expected to be significant.

Consequently, for the shielding of the cyclotron, the main source of radiation to consider was the beams on Faraday ups; Hence, this study was looking at the optimal shielding design especially when the proton beams hit the Faraday cups during optimization of the cyclotron beam-line parameters. This study was conducted using the FLUKA Monte-Carlo transport code.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

Yes

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Nuclear, Particle and Radiation Physics 1 / 414

PLASMA DIAGNOSTICS ON THE ECRIS

Author: Muneer Sakildien[1]

Co-authors: Fhumulani Nemulodi [1]; Pete Jones [1]; Rainer Thomae [1]

[1] *iThemba LABS*

Corresponding Author: muneer@tlabs.ac.za

Various techniques are applied to Electron Cyclotron Resonance Ion Sources (ECRIS) to enhance high charge state ion beam production, but many of these remain not well understood. With Kα plasma diagnostics it is possible to develop a greater understanding of these techniques and in so doing improve the performance of the ion source for high charge state production. Two of the most commonly used techniques are gas mixing and double frequency heating. Here we will report on the results of preliminary measurements on the ECR ion source at iThemba LABS and discuss future measurements

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Pete Jones
pete@tlabs.ac.za

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Applied Physics / 415

Weather forecasting using deep learning

Author: Makhamisa Senekane[1]

Co-authors: Mhlambululi Mafu [2]; Molibeli Taele [3]

[1] *Quantum Research Group, School of Chemistry and Physics, University of KwaZulu-Natal, Private Bag X54001, Durban 4000, South Africa*

[2] *Botswana International University of Science and Technology*

[3] *National University of Lesotho*

Corresponding Author: makhamisa12@gmail.com

Weather changes play a significant role in peoples' short term, medium term or long term planning. Therefore, understanding of weather patterns has become very important in decision making. Various tools have been suggested for forecasting weather. These tools include the use of artificial intelligence techniques such as artificial neural networks and other machine learning methods. In this paper, we report a short-term weather forecasting method which uses deep learning machine learning technique. Deep learning is chosen due to its hierarchiacal structure, which is well suited for weather forecasting. High accuracy of the results obtained shows that deep learning is an appropriate tool to use for forecasting the weather.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Nuclear, Particle and Radiation Physics 1 / 416

SAIF - the South African Isotope Facility

Author: Robert Bark[1]

[1] *iThemba LABS*

Corresponding Author: bark@tlabs.ac.za

The iThemba LABS' Radioactive-Ion Beam project has evolved into SAIF - the South African Isotope Facility. It has two phases, the first of which comprises the Low-Energy Radioactive-Ion Beam (LERIB) project and ACE Isotopes (Accelerator Centre for Exotic Isotopes) project. ACE isotopes calls for the installation of a commercial, off-the-shelf 70 MeV cyclotron for radionuclide production. It will remove isotopes production from the existing SSC accelerator, freeing additional beam time for research. The LERIB project is an upgraded version of the RIB "demonstrator", capable of producing neutron-rich beams of high-intensity, due to the fissioning of natural uranium at a rate of up to 6 x 10¹³/s. The beams from LERIB will be of low-energy, 60 keV - suitable for decay studies and implantation in materials as radioactive probes. Phase 2 of the SAIF project is the Accelerator Centre for Exotic Beams (ACE Beams). It will see the addition of a post-accelerator, likely a LINAC, to take beams from the LERIB to high-energies for research into sub-atomic physics.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Physics of Condensed Matter and Materials 1 / 417

Transformation of plant biomass waste into resourceful activated carbon materials for mixed-assembly type electrochemical capacitors

Author: Damilola Momodu[1]

Co-authors: Chiamaka Okafor [2]; Esidor Ntsoenzok [3]; Martiale Gaetan Zebaze-Kana [4]; Ncholu Manyala [5]

[1] *UNIVERSITY OF PRETORIA*

[2] *African University of Science and Technology, Abuja*

[3] *Centre National de la Recherche Scientifique, Orleans, France*

[4] *Kwara State University*

[5] *University of Pretoria*

Corresponding Author: dymomodu@yahoo.com

Activated carbon (AC) was obtained from three different plant biomass wastes sources (coconut shell, pine cones and rice husk) via hydrothermal treatment followed by carbonization at 800 ℃. The morphological and structural characteristics of the transformed carbon material revealed a porous network suitable for energy storage application. The asymmetric cells fabricated exhibited EDLC behaviour in all material sample combinations using all three transformed activated carbons. The mixed assembly device worked comfortably in a voltage window of 1.5 V in a neutral electrolyte. A specific capacitance (Cs) of ~110 F g⁻¹ was obtained with a corresponding energy density of 8.5 W h kg⁻¹ and power density of 380 W kg-1 at a current density of 0.5 A g⁻¹. An excellent stability was exhibited with a coulombic efficiency of a 99.7% and capacitance retention of 80% after 10000 continuous cycling at 5.0 A g⁻¹. Furthermore, subjecting the device to a floating test for ~48 h (2 days) at the optimum voltage (1.5 V) revealed a drop in the initial capacitance value but still without any recorded device failure. Remarkably, the asymmetric design showed a potential for adopting EDLC materials of different carbon sources in order to capture the entire properties for efficient and stable energy storage devices.

Summary:

Keywords: Plant waste; Energy storage materials; Activated carbon; Mixed-assembly; Supercapacitors

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

Prof. N. Manyala
University of Pretoria

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 71 / **418**

Jitter Analysis of Pulse-Per-Second Timing Signals Transmitted over Optical Fibre Networks

Author: KAGISO J LEBURU[1]

Co-authors: Andrew Leitch [2]; Duncan Boiyo [3]; Romeo Reginald Gunther Gamatham [4]; Timothy Gibbon [5]

[1] *NELSON MANDELA METROPOLITAN UNIVERSITY*

[2] *NMMU*

[3] *Centre for Broadband Communication, Nelson Mandela Metropolitan University*

[4] *NRF, Square Kilometre Array South Africa*

[5] *NMMU Physics Department*

Corresponding Author: leburujk@gmail.com

Telescope networks rely on high frequency clock tones to be distributed to each antenna for driving the digitizers, time stamping the data and for monitoring and control functions. Stringent timing signals also find use in organisations like Square Kilometre Array, National Metrology Institute of South Africa, Coordinated Universal Time and Global Positioning System; as well as in areas of financial systems, telecommunications, transport and the military. However, clocks suffer from time deviation from the true periodicity, known as jitter. Jitter is contributed by noise, thermal effects, and aging of clocks. It can be either random or deterministic. In this study we analyse the jitter contributed by transmission of pulse-per-second (PPS) timing signals over typical optical fibre networks. The PPS timing signals were transmitted in G.652 optical fibre of length 3.21 km. A 1310 nm Vertical Cavity Surface Emitting Laser, biased at 4.79 mA, was modulated using PPS signals. The overall jitter contribution from the optical fibre transmission was found to be 202 picoseconds. This means that the PPS signals' periodicity deviates by this value, and may cause signal delays in communication and timing systems. This value agrees with the typical acceptable jitter ranges of pico- to femtoseconds. For stringent timing applications, jitter correction mechanisms may be required to effectively compensate for the jittery in such systems.
Keywords: Timing signals, PPS, Jitter, Optical fibre networks

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

MSc

**Main supervisor (name and email)
and his / her institution**:

T.B. Gibbon
Tim.Gibbon@nmmu.ac.za
Centre for Broadband Communication, Physics Department, Nelson Mandela Metropolitan University, P. O. Box 77000, South Campus, Summerstrand, Port Elizabeth, 6031, South Africa

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Astrophysics / **419**

Investigating HI Intensity Mapping Techniques with KAT-7 Via Simulations

Author: THEOPHILUS ANSAH-NARH[1]

Co-author: Oleg Smirnov [2]

[1] *RHODES UNIVERSITY*

[2] *Rhodes University*

Corresponding Author: philusnarh@gmail.com

The emerging observation technique to probe dark energy is HI intensity mapping (IM). The technique mainly depends on mapping the integrated intensity of HI (21 cm) emission of each pixel on the sky without absolutely resolving individual galaxies. However, the technique is faced with some challenges in terms of data analysis and specifically, in measuring the primary beam response of our instrument. Thus, the primary beam modulates the intensity as a function of sky position, which is precisely what is being measured by intensity mapping
experiment in the first place. This has to be overcome in order to make such an experiment work to the best of its capabilities. We present a raster scan simulation of autocorrelation observations with KAT-7 using OSKAR and then compare our output to existing HI intensity mapping data observed with KAT-7.

Summary:

Unlike radio interferometers which can produce direct imaging by just taking the Fourier transform of visibilities, single dish mode of observation, on the other hand, can not bring up an automatic imaging, alternately, we can apply other techniques such as the raster scan observation approach to achieve this.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. Oleg Smirnov, osmirnov@gmail.com.

Institution:: Rhodes University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 72 / **420**

Mapping the effects of thermal gradients for correction of refractive index variation inside the lunar laser ranging telescope tube

Author: Tsele Philemon[1]

Co-authors: Combrinck Ludwig [2]; Ngcobo Bongani [1]

[1] *University of Pretoria*

[2] *Hartebeesthoek Radio Astronomy Observatory*

Investigating the magnitude of air temperature variation inside the Lunar Laser Ranger (LLR) telescope tube is important for determining the varying refractive index and divergence angle of the emitted laser beam along the optical axis. Such investigation is important for the operational performance of optical laser telescopes, particularly the LLR one-meter aperture telescope that is under development at the Hartebeesthoek Radio Astronomy Observatory (HartRAO) which is expected to

achieve sub-centimeter range precision to the Moon, for enhanced tests of Earth-Moon system dynamics. In particular, this study presents analysis of the inside-tube air temperature variation along the optical axis of the LLR tube assembly model as a result of pre-set ambient temperature and wind conditions that are representative of the HartRAO site. Results show that with ambient temperature and wind speed of 30 ℃ and 8 km/h respectively; air temperature decreases from the inner-tube surface (˜29.95 ℃) toward the tube center (˜28.95℃) with regional temperature variations of about 0.1 ℃ occurring in a radial manner over a time period of an hour. The results of the simulations indicate that larger variation in the refractive indices occurs closer to the secondary mirror. Furthermore, we report on the refractive indices and divergence angle estimated for different temperatures along the tube optical path. These findings indicate that the variation of the index of refraction must be compensated in areas away from the primary mirror. This has significant implications for providing options for active thermal mechanisms for the tube assembly.

**Apply to be
 considered for a student
   award (Yes / No)?**:

Yes

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

PhD

**Main supervisor (name and email)
and his / her institution**:

Prof. Ludwig Combrinck

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Theoretical and Computational Physics 1 / 421

Division Meeting

Nuclear, Particle and Radiation Physics 1 / 422

Divisional Meeting of Nuclear, Particle, and Radiation Physics

Corresponding Author: smm@tlabs.ac.za

Nuclear, Particle and Radiation Physics 1 / 423

Cross section measurements of light ion production using (p,xp) and (p,xn) reactions

Author: Doris Kenfack[1]

[1] *University of Stellenbosch*

Corresponding Author: smm@tlabs.ac.za

Neutron-rich beams are being developed at iThemba LABS to study nuclear structure away from the stability. This is also the opportunity of deepening our understanding of astrophysical origin of elements. The primary beam is expected to be an intense 70 MeV proton beam. Several techniques

using proton induced reactions have been developed to produce exotic nuclei. The interest of using (p,xp) and (p,xn) reactions lies in the fact that proton beams have a large penetrating power and can be produced with high intensity. Some preliminary measurements were performed at iThemba LABS using, 7Li, 9Be and natB targets with protons projectiles of energy 66 MeV. The nuclides of interest 6He, 8Li and 9Li were identified. Further cross section measurements are planned using a beam chopper being installed at iThemba LABS. The detection setup includes two electron spectrometers composed of a 5mm thick plastic scintillator, for energy loss measurement, and a thin window Gemanium detector (LEPS) for residual energy measurement. The E-DeltaE technique with this combination of detectors allows particle identification and high-resolution measurement simultaneously. The results of this investigation will be used to evaluate the feasibility of light neutron rich beams at iThemba LABS.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Nuclear, Particle and Radiation Physics 1 / 424

High Power Laser System at the Extreme Light Infrastructure – Nuclear Physics

Author: Ioan Dancus[1]

[1] *ELI-NP*

Extreme Light Infrastructure – Nuclear Physics (ELI-NP) will be a new Center for Scientific Research to be built by the National Institute of Physics and Nuclear Engineering (IFIN-HH) in Bucharest-Magurele, Romania. The Extreme Light Infrastructure was included in the 2006 Roadmap of the European Strategic Forum for Research Infrastructure (ESFRI). ELI-NP is a complex facility which will host two state-of- the-art machines of high performance, unique in the world through the design parameters: a very high intensity laser system with two 10 PW laser beams (HPLS), and a very intense, brilliant γ beam (GBS).

The ELI-NP HPLS is a Ti:Sapphire, hybrid CPA system and it has six optical outputs: two 0.1 PWoutputs running at 10 Hz repetition rate, two 1PW outputs running at 1 Hz and two 10 PW outputs running at 1 shot per minute. This laser system is produced by a consortium formed by THALES Optronics and THALES Systems Romania. The Laser Beam Delivery (LBD) system interfaces the HPLS with the Nuclear Physics facility and with the experiments. It comprises the optical output delivery, laser pulse adaption on demand, pulse quality management, and electronic synchronization of the HPLS with the GBS and with the experiments. During my presentation, I will concentrate on the HPLS description and integration in the ELI-NP facility.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Nuclear, Particle and Radiation Physics 1 / 425

Nuclear Physics with High Power Lasers at ELI-NP facility

Author: Florin Negoita[1]

[1] *ELI-NP*

Corresponding Author: smm@tlabs.ac.za

ELI-NP facility, the Nuclear Physics pillar of the Extreme Light Infracture under construction in Europe, will host a High Power Laser System delivering two laser beam with powers up to 10 PW and a Gamma Beam System providing high intensity, narrow bandwidth, gamma ray of tunable energy up to 20 MeV. The current achivements on proton and heavy ions acceleration with exiting 1 PW laser facilities will be review and expected improvements using 10 PW laser pulses will be presented. The high particle density and short duration of laser accelerated ion bunches are advantages that enable new methods for the study of nuclear structure and reactions compared to ion beams produced with classical accelerators. The changes of reaction cross sections or of apparent lifetimes in hot plasma environments, new techniques for heavy unstable nuclei ion production are examples that will be detailed in the presentation as well as posible applications such as medical radioisotope production. The technological chalanges of these studies will be adrressed too.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

Yes

Applied Physics / 426

Wolfram Mathematica - a practical toolset for applied and experimental physics

Author: Clemens Dempers[1]

[1] *Blue Stallion Technologies*

Wolfram Mathematica, and the Wolfram Language offers a wide range of integrated tools that can accelerate research and teaching by rapid modeling. With many universities in South Africa having Wolfram site licenses, it is important to make physics students and lecturers aware that they have access to a varied and powerful toolset. The author will present practical interactive applications including monitoring environmental data, importing data from sensors, interactive curve fitting and automating data collection.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

No

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Physics Education / 427

Non-specialist talk - Cool science does not have low kinetic energy

Author: Peter Horszowski[1]

[1] *PERT INDUSTRIALS*

In a recent interview, Stirling Prize winning Architect Amanda Levete said that when she was young, in the sixties, being naughty was considered cool but in the 21st Century it is cool to be clever. It is contended in this paper that there are different kinds of 'clever'. In the age of Google , we argue, it is not fact knowledge but rather creative problem solving that attracts a student to science. We review a number of example activities in Newtonian mechanics, chemical dynamics and gas laws and show ways in which a particular experimental structure can captivate a student's imagination. We conclude with a short philosophical discussion on the need for an educational paradigm shift in 2017, where, as it is remarked at ShiftHappens.com : we are now educating students to solve problems we don't have, to do jobs that don't exist and to use technology that has not been invented.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Astrophysics / 428

Non-specialist talk - Extragalactic Science with H.E.S.S.

Corresponding Author: markus.bottcher@nwu.ac.za

This talk provides a general introduction of the High Energy Stereoscopic System (H.E.S.S.), the world's largest ground-based gamma-ray observatory, located near Windhoek, Namibia. I will then present some highlights of extragalactic science done with H.E.S.S., including the study of active galactic nuclei, rapid follow-up observations of transients (including gamma-ray bursts), the search for signatures of dark-matter annihilation, and the study of physics beyond the standard model.

Astrophysics / 429

DST Feedback Session

Corresponding Author: markus.bottcher@nwu.ac.za

Astrophysics / 430

Division Meeting

Corresponding Author: christo.venter@nwu.ac.za

Astrophysics / 431

Modelling Polarization by the Inverse Compton Scattering Process

Corresponding Author: baibhawdps@gmail.com

Synchrotron Radiation(SR) and Inverse Compton Scattering(ICS) are the two prime processes which lead to X-Ray and Gamma Ray emission in Gamma Ray Bursts and Active Galactic Nuclei. We focused on the ICS of relativistic electrons on target photon fields and studied the polarization of outgoing photons. We present the results by analyzing the cross section of the scattering process and the associated Stokes Parameters, considering initially unpolarized photons with no preferred incoming direction. The calculations were done over the whole energy spectrum for both thermal and non-thermal distributions of electrons.

Photonics Winter School / 432

The development of a laser based 3D fingerprint acquisition device

Corresponding Author: asharma@csir.co.za

Photonics Winter School / 433

Biomedical Imaging with micro-fabricated optically pumped magnetometers

434

Tea

Photonics Winter School / 435

Biomedical detection using optical phenomena

Photonics Winter School / **436**

Precision time and frequency metrology with light

Photonics Winter School / **437**

Generation of a gamma ray laser

Corresponding Author: shconnell@uj.ac.za

Photonics Winter School / **438**

Precision molecular spectroscopy for astrophysics

Corresponding Author: cmsteen@sun.ac.za

Photonics Winter School / **439**

Novel techniques for optical metrology using structured light

Poster Session 2 - Board: 36 / **440**

TiO2 Nanorods Formation Mechanism on Ti Foil Substrate by Gel-Oxidation Method

Author: Crispin Mbulanga[1]

Co-author: Stive Roussel Tankio Djiokap [1]

[1] *Nelson Mandela Metropolitan University*

Gel-oxidation method is a thermochemical method used to modify and form surface layers on Ti surface by controlling the thickness and morphology of surfaces. It can be described in terms of the following two-step process: (i) gelation: a Titanium based hydrogel is formed on Ti surface from corrosive reagent such as NaOH, KOH, LiOH, H2O2, …; and (ii) oxidation: the hydrogel is oxidised at various temperatures, thereby forming a surface layer of recrystallized titania (TiO2) and possibly other phases, such as alkaline (Na, …) titanate, on the surface [1] [2] [3] [4]. Hence, the aim of the present investigation is to explore the formation mechanism that leads to the synthetisation of TiO2 nanorods on metallic substrate, in particular Ti foil surface by gel-oxidation NaOH based method.

From XRD, SEM, TEM and Raman spectroscopy investigations, the following observations were made: (1) On the surface of Ti foil treated in 5 M NaOH solution at 76 oC for 24 h, there is a porous

network morphology made of predominantly amorphous with a small amount of nanocrystalline; (2) anatase and rutile TiO2 nanorods formation take place on the surface of NaOH-treated Ti foil calcinated (oxidised) at 600 and 800 oC under a N2 flow; (3) rutile TiO2 nanostructures formation take place efficiently on the surface of NaOH-treated Ti foil calcinated (oxidised) at 800 oC under a N2 flow. After a careful interpretation of above results, it is understood that TiO2 fabricated nanorods inherited their morphology from Na Titanates.

References
[1] H.Z. Abdullah, P. Koshy and C.C. Sorrell, "Gel Oxidation of Titanium for Biomedical Application," Adv. Mater. Res., vol. 620, p. 122, 2013.
[2] H.Z. Abdullah and C.C. Sorrel, "Gel Oxidation Of Titanium And Effect Of UV Irradiation On Precipitation Of Hydroxyapatite From Simulated Body Fluid," Advanced Materials Research, Vols. 488-489, p. 1229, 2012.
[3] Hyun-Min Kim, F. Miyaji, T.Kokubo,' and T. Nakamura, "Preparation of bioactive Ti and its alloys via simple chemical surface treatment," J. Biomed.l Mater. Res., vol. 32, p. 409, 1996.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Main supervisor (name and email)
and his / her institution**:

J.R. Botha, , Nelson Mandela Metropolitan University

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Teacher's Workshop / 441

Opening remarks

Teacher's Workshop / 442

South African Physics Olympiad

Corresponding Author: particles@mweb.co.za

Teacher's Workshop / 443

Teacher professional development

Teacher's Workshop / 444

Work-energy theorem

Corresponding Author: msherbert@uwc.ac.za

Teacher's Workshop / 445

Preparing for young physicists tournament

Corresponding Author: dduffield@parklands.co.za

Teacher's Workshop / 446

Women in physics

Corresponding Author: dwolfe@unm.edu

Teacher's Workshop / 447

Teaching with MCQ

Corresponding Authors: particles@mweb.co.za, dwolfe@unm.edu

Teacher's Workshop / 448

Decolonialising science education

Corresponding Author: dl.taylor@uct.ac.za

Physics of Condensed Matter and Materials 1 / 449

DPCMM AGM

Photonics / 450

Beam shaping with controllable gain

Author: Igor Litvin[1]

Co-author: Hencharl Strauss [2]

[1] *CSIR NLC*

[2] *CSIR (National Laser Centre)*

We propose a novel laser beam shaping technique based on the manipulation of the transverse gain profile in the laser crystal. The method allows controllable reshaping of a laser output beam into a desired beam profile. The proposed technique was successfully tested by both laser and laser amplifier systems with controllable gain. Two laser diodes were used to pump the crystal and to create a desirable pump beam profile. By independent manipulation of output powers of both pump diodes we are able to perform a controllable operation both the laser output intensity profile and transverse intensity of amplified laser beam.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Poster Session 1 - Board: 35 / **451**

Computational modelling for understanding the fundamentals of methane oxidation over palladium oxide

Author: Moyahabo Hellen Chuma[1]

[1] *Johnson Matthey*

Corresponding Author: hellen.chuma@matthey.com

One of the main challenges in natural gas engine after treatment is the combustion of methane at lower temperatures. The presence of water and sulphur in the engine exhaust lowers the catalyst performances. With various computational simulations, we are developing models that will assist in understanding the fundamentals of these reactions and making predictions for further improvements of the catalysts.
The grid-based projector-augmented wave (GPAW) method has been used to determine the reaction path of methane oxidation over PdO surfaces. This lead to an understanding of the complete catalytic combustion of methane at a range of temperatures as well as the resultant production of CO₂ and H₂O. A series of dopants has been introduced to the surface model to determine the effect of doping on PdO. Reaction profiles are mapped out and preliminary results will be presented.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Teacher's Workshop / 452

Making calculus, linear and quadratic graphs real in the context of position, velocity and acceleration-time graphs

Corresponding Author: thefish@iafrica.com

Teacher's Workshop / 453

Giving real meaning to gradients and intercepts through experiments from chemistry, gas laws, electricity and physics

Corresponding Author: thefish@iafrica.com

Applied Physics / 454

Applied Physics Forum AGM

Teacher's Workshop / 455

Sense-making in physics

Corresponding Author: saalih.allie@gmail.com

456

Local core -cluster interaction of Saxon-Woods type with parameters derived from the Michigan-3-Yukawa (M3Y)

Author: Toafiq Ibrahim[1]

[1] *University of Ilorin, Nigeria*

Local core -cluster interaction of Saxon-Woods type with parameters derived from the Michigan-3-Yukawa (M3Y) microscopic potential model have been used to investigate the properties of nuclei in different mass regions. In the light and heavy nuclei the hybrid potential model predicts under-bound ground-states pointing to a shortcoming of the potential model in the internal region. This is taken to be due to a possible core-cluster overlap corrected by an additional interaction in the interior. Good agreement is found between the experimental data and the model predictions of the alpha-decay properties of super-heavy nuclei.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Plenary 3 / 457

From Ordinary to Extraordinary: Quantized Materials and Device Physics

Author: Deji Akinwande[1]

[1] *University of Texas – Austin*

This general talk will present our latest research advances on 2D nanomaterials towards greater scientific understanding and advanced engineering applications. In particular the talk will highlight our work crossing many disciplinary domains including flexible devices/nanoelectronics, wearable sensors, coupled opto-electro-mechanics, topological semiconductors, and non-volatile ionic phenomena. Finally, recent transitional advances from the laboratory to commercialization of graphene and quantized materials will be featured.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/a

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Plenary 1 / 458

Faltering Steps into the Galaxy

Author: Gary P. Zank[1]

[1] *University of Alabama in Huntsville*

Voyager 1 has now entered the interstellar medium, a moment of great historical import. We describe the Voyager 1 magnetic field and energetic particle observations, the initial uncertainty surrounding a possible crossing of the heliopause, and the eventual clarification by the Plasma Waves Analyzer. The interaction of the solar wind and the interstellar medium is complicated by the presence of neutral hydrogen that is coupled via charge exchange to the plasma. We present the current status of theory, models, and simulations, describing the highly non-equilibrated interaction and the underlying physics. We conclude by discussing briefly related interactions of stellar winds with their local environments.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Plenary 2 / 459

Opening New Frontiers in Nuclear Science and applications and Moving Forward with iThemba LABS' Long Range Plan

Author: Faical Azaiez[1]

[1] *iThemba Labs*

The iThemba Laboratory for Accelerator Based Sciences (iThemba LABS) is a National Research Facility. It is also the premier atomic particle accelerator laboratory on the African continent and the only facility of its kind in the southern hemisphere. The facility contributes to the National System of Innovation (NSI) through the provision of unique research infrastructure platforms supported by highly skilled scientists, and operations staff. The research agenda of the facility is based largely on the Separated Sector Cyclotron (SSC), a particle accelerator which produces particle beams for research.

iThemba LABS plays a pivotal role in the NSI through its collaboration network with South African Universities and Institutions. The facility enjoys a prominent global position and plays a critical role in co-ordinating African contributions in collaborative initiatives with prestigious institutions like the European Organisation for Nuclear Research (CERN) and the joint Institute for Nuclear research (JINR) in Russia. The research and production of accelerator-based radioisotopes is a demonstration of basic and applied research being translated into innovative real world solutions.

iThemba LABS has adopted through its Long Range Plan exercise an ambitious strategy to create the South African Isotope Facility (SAIF). The plan will be executed mainly through the acquisition of a new 70 MeV cyclotron, and is based on two phases namely:
- Establishment of the Accelerator Centre for Exotic Isotopes (ACE Isotopes) which will allow the migration of the radioisotope production programme from the existing particle accelerator (the SSC) to the proposed new 70MeV cyclotron. This will then release capacity on the existing SSC to be entirely devoted to the transdisciplinary research agenda of the facility which will thus meet the requirements of its national and international stakeholders.
- Development of the Accelerator Centre for Exotic Beams (ACE Beams) which will support the production of artificially produced isotopes which will allow iThemba LABS to seriously expand their research agenda in this area. The production of exotic beams will invigorate basic and applied research from innovative cancer therapy treatment modalities to understanding the origin and creation of chemical elements in the universe, the latter being already started with the building of the Low Energy Radio-active Ion Beams facility.

The SAIF project as part of the Long Range Plan of iThemba LABS will be discussed.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Plenary 1 / 460

Magnetic Imaging with Optically-Pumped Magnetometers

Author: Svenja A. Knappe[1]

[1] *University of Colorado - Boulder*

Several miniaturized Quantum Sensors use laser spectroscopy of atoms to achieve very good performance. Optically-Pumped magnetometers (OPMs), also called atomic magnetometers, use light to polarize atomic spins of atoms. The spins precess in a magnetic field and the precession frequency is a measure of the magnetic field. Our effort focusses on miniaturizing these OPMs with sensitivities approaching those of superconducting quantum interference device (SQUID) magnetometers. These magnetometers are used for magnetic imaging applications in applications ranging from biomagnetic imaging of the heart and brain, to geophysical imaging and magnetic anomaly detection.

The highest sensitivities are required in magnetoencephalography (MEG), where the magnetic fields are recorded with a sensor array arranged around the head of a subject. It allows to image the neural activity inside the head with high spatial and temporal resolution. Sensor designs and performance will be presented as well as their characterization in several applications.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Plenary 1 / 461

FAIR - The Universe in the Laboratory

Author: Karlheinz Langanke[1]

[1] *GSI Helmholtzzentrum fuer Schwerionenforschung and Facility for Antiproton and Ion research*

FAIR will be the next-generation facility for fundamental and applied research with antiprotons and ion beams. It will provide world-unique accelerator and experimental facilities, allowing for a great variety of unprecedented forefront research in physics and applied sciences. FAIR is an international project with 10 partner countries and more than 2500 scientists and engineers from more than 50 countries involved in the planning and construction of the accelerators and associated experiments.

FAIR research focuses on the structure and evolution of matter on both a microscopic and a cosmic scale, bringing our Universe into one laboratory.
In particular, FAIR with its four scientific pillars will expand the knowledge in various scientific fields beyond current frontiers, addressing the following:

- The properties of the strong force and its role in shaping the basic building blocks of the visible world around us and in the evolution of the universe;
- Test of symmetries and predictions of the Standard Models, as well as the search for physics beyond it;

- The properties of matter under extreme conditions, at both the subatomic and the macroscopic scale of matter; and
- Applications of high-intensity, high quality beams in research areas that provide the basis for, or indirectly address, issues of applied sciences and technology.

In particular FAIR will open a new era in nuclear astrophysics.

The talk will introduce FAIR and its unique scientific opportunities.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Plenary 1 / 462

Photonic Crystals

Author: Solomon Assefa[1]

[1] *IBM Research Lab Africa*

TBA

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Plenary 2 / 463

Intercalated carbon materials at extreme conditions

Author: Vittoria Pischedda[1]

[1] *ILM*

The high pressure and high temperature phase diagrams of intercalated carbon materials offer novel approaches for the engineering of new carbon functional materials. In this talk I will explore the structural, electronic, and vibrational properties of intercalated 2D fullerites and graphites when submitted to severe high pressure conditions. In graphite and fullerites, the graphene layers or the fullerenes molecules are held together in the crystal structure by the weak van der Waals forces and intercalation is easy due to the low energies involved. The guest-host charge transfer which may occur, results in profound modifications of the physico-chemical properties of the host. Applying external pressure to these materials provokes the contraction of bond lengths, leading to drastic changes such as sp2-sp3 C transitions, anisotropic and isotropic deformation, and insulator-metallic transformations. When the energetic landscape is favorable, the metastabilization of new forms of carbon allotropes at ambient conditions can occur.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Public Talk / 464

Stepping into the ligth with High Power Laser and Brilliant Gamma beams at ELI-NP

Author: Sydney Gales[1]

[1] *ELI*

Laser intensities have increased by 6 orders of magnitude in the last few years. These are now so large that the laws of optics change in fundamental ways, thus opening up the new field called relativistic optics. The development of high power lasers and the combination of such novel devices with accelerator technology has enlarged the science reach of many research fields, in particular particle and nuclear physics, astrophysics as well as societal applications in material science, nuclear energy and applications from cultural heritage to biology, medicine, and space .
The European Strategic Forum for Research Infrastructures has selected a proposal based on these new premises called the Extreme Light Infrastructure (ELI). One important aspect of ELI is the possibility to produce ultra-short pulses of high energy photons, electrons, protons, neutrons, muons, and neutrinos. In this time-domain (femto to attoseconds, 10-15s and below) experimental studies will allow unravelling the dynamics in atomic, molecular physics, plasma and sub-nuclear physics.
The ELI will be built as a network of three pillars in Hungary, Czech Republic and Romania at the frontier of laser technologies. The ELI-NP pillar (NP for nuclear physics) is under construction near Bucharest (Romania) and will develop a scientific program using two 10 PW lasers and a Compton back-scattering high-brilliance and intense low-energy gamma beam. This unique combination of beams worldwide allows us to develop an experimental program at the frontiers of present-day knowledge as well as society driven applications. In particular ELI-NP particle acceleration experiments will explore unchartered territory of high power femtosecond laser (HPL) interaction with matter, like for Table-Top Laser-based source of femtosecond, collimated, ultrarelativistic electrons beams, and high energy of ions and neutron beams.
In the present paper, after an introduction to high power laser science and of its development worlwide, we will describe the present status the implementation of the ELI-NP facility as well as the new perspectives in Nuclear Physics and Astrophysics and their applications. We will illustrate through specific examples the impact of this emerging science on the some hot societal issues (health, energy) and on the economical and educational potential of this Large Scale Facility in the host country.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Applied Physics / 465

Long-Term Performance Assurance Strategies for Photovoltaic Modules Deployed in South Africa

Author: Frederik Vorster[1]

Co-authors: Ernest van Dyk [1]; Jacqui Crozier [1]

[1] *NMMU*

South Africa has experienced an unprecedented growth in the deployment of photovoltaic (PV) systems during the last ten years. This growth can partly be attributed to the prospect of producing electricity cheaper than the local (municipality) or national (ESKOM) electricity utility supplier, thus providing a good investment vehicle for sustained high capital growth. This favourable scenario is however only possible if the photovoltaic system performs as predicted over the life-span of the system.
This presentation will describe, discuss and highlight the importance of the quality of PV modules and the important role that various module tests can play to reduce the risks associated with investments in PV systems. The various pv module tests can be divided into post-manufacturing, pre-deployment, post deployment and periodic testing during the operational lifetime of the module. The results from some of these tests will be presented and discussed to illustrate their important benefits.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

Yes

Plenary 3 / 466

The European Spallation Source – 21st century possibilities for science using neutrons

Author: Andreas Schreyer[1]

[1] *European Spallation Source ESS ERIC*

The European Spallation Source will be the world leading neutron source enabling new science, which was not possible so far. After a short summary of the design and the specifications of the ESS an overview of the current status and schedule of the ESS construction project will be given with a strong focus on the instruments and the surrounding scientific infrastructure. The overall goal of ESS is to begin user operation with 8 instruments in 2023. The plan is to reach the full scope of 22

public instruments by 2028. ESS will cover a very broad spectrum of science and is designed to push the limits of neutron methods to new horizons. Examples of new scientific opportunities will be discussed.

Photovoltaics Workshop / 467

PV Penetration (worldwide and SA) and RE IPPP status

Corresponding Author: kroro@csir.co.za

Photovoltaics Workshop / 468

Solar Resource

Photovoltaics Workshop / 469

PV device technology

Corresponding Author: frederik.vorster@nmmu.ac.za

Photovoltaics Workshop / 470

Defects, degradation and characterization

Photovoltaics Workshop / 471

PV Plant engineering and optimisation (utility scale)

Photovoltaics Workshop / 472

PV Plant engineering and optimisation (commercial and industrial sectors)

Photovoltaics Workshop / 473

PV Plant characterisation

Corresponding Author: frederik.vorster@nmmu.ac.za

Photovoltaics Workshop / 474

Panel discussion

WiPiSa - Public Talk / 475

Women under pressure

Author: Sylvie Le Floch[1]

Co-author: Vittoria Pischedda [1]

[1] *Univ Lyon, Université Claude Bernard Lyon 1, CNRS, Institut Lumière Matière, F-69622, VILLEURBANNE, France*

High pressure is powerful means to study and modulate properties of materials and to design new materials with interesting applications in many fields. What are the challenges related to the study of materials under extreme conditions? And what are the challenges for women who break the stereotypes using diamonds just to squeeze their samples? Two women researchers will present their careers and illustrate them with their scientific and technological successes. The place of female scientists working in (and under!) pressure will be sketched through the newborn international network “Women under High Pressure”.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Poster Session 2 - Board: 86 / **476**

Extensions of THERMUS and its Applications in High Energy Particle collisions

Author: DAWIT WORKU[1]

[1] *Cape Peninsula University of Technology*

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.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

477

Sense – making difficulties: an example from DC circuits.

Author: Ignatius John[1]

Co-author: Saalih Allie [2]

[1] *CPUT*

[2] *UCT*

Corresponding Author: johni@cput.ac.za

Sense–making in physics is regarded as a key step towards understanding as opposed to answer – making and rote learning. Thus, getting students to start with their own prior experiences and "refining" them to the point where they are consistent with the physics concepts, is very much encouraged in the classroom situation. However, in some contexts sense-making can lead to canonically incorrect ideas. The present study shows how a student who is clearly trying to make sense of a task, is misled by incorrectly interpreting a past experience. The talk will focus on an interview that formed part of a larger study into aspects of DC circuits that has recently been described in detail in ref1 and ref2. A brief summary of the background will be provided in order to understand the context of the interview.

Ref 1: Ignatius John and Saalih Allie, DC circuits: I. Evidence for fine grained contextual dependence, Eur. J. Phys. 38 (2017) 015701 (22pp).

Ref 2: Ignatius John and Saalih Allie, DC circuits: DC circuits: II. Identification of foothold ideas in DC circuits, Eur. J. Phys. 38 (2017) 015702 (20pp).

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Poster Session 1 - Board: 79 / **478**

Validation of the interpolation of geomagnetic field measurements over Southern Africa by means of Spherical Equivalent Current Systems

Author: Corrinne Florie[1]

Co-authors: Dan Welling [1]; Mark Moldwin [1]; Pierre Cilliers [2]

[1] *University of Michigan, USA*

[2] *SANSA Space Science*

Geomagnetically Induced Currents (GICs) are considered to be one of the major space weather related threats to terrestrial technological systems. The change of magnetic flux and induced geoelectric field along power lines is the key driver of GICs in power distribution systems. The electric field is derived from the local geomagnetic field and the local surface impedance under the power lines. One of the key steps in deriving the electric field, and in turn, induced currents, is the interpolation of the geomagnetic field from the locations of the nearest geomagnetic observatories to the location of the power lines.
A commonly used approach to finding the geomagnetic field at the location of the power lines, is to apply the method of Spherical Equivalent Current Systems (SECS). The SECS method estimates the characteristics of a hypothetical array of current elements in the ionosphere, based on measurements of the geomagnetic field at several locations on the ground, typically at magnetic observatories. The Biot-Savart Law is then applied to the x- and y- components of the currents to find the By and Bx components, respectively, of the magnetic field on the ground at any points of interest.
There are four geomagnetic observatories in Southern Africa, which are located at Hermanus (19.43°E,33.22°S), Hartebeesthoek (25.88°E,27.70°S), Tsumeb (19.20°E,17.58°S), and Keetmanshoop (26.32°E,18.06°S). The interpolation of the measurements from these observatories, as done by means of the SECS method, is validated by comparing the interpolated field with measured fields at the locations of a number of Magnetotelluric stations, and by comparing a modelled geomagnetic field over the region, as derived by means of the Space Weather Modelling Forum (SWMF) from the University of Michigan, with the interpolated field at a 2 x 2 degree grid over Southern Africa.
This approach provides an estimate of the accuracy of the SECS-interpolation vs. location over Southern Africa, in order to provide an estimate of the accuracy of the GICs that may be inferred from these observations.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 80 / **479**

SQUID Magnetometer Calibration and Data Analysis

Author: Dominique John[1]

Co-authors: Elda Saunderson [2]; Mark Moldwin [1]

[1] *University of Michigan, USA*

[2] *SANSA*

The SQUID (Superconducting Quantum Interference Device) is a very sensitive magnetometer that measures magnetic flux using flux quantization and Josephson tunnelling. Compared to traditional fluxgate magnetometers, SQUIDs could detect and measure flux to a femtotesla. SQUIDs are prospective instruments for the use of monitoring geomagnetic storms and predicting space weather due to their sensitivity and accuracy for measuring the Earth's magnetic field. Assessments have shown that this is the case for when SQUIDs are unshielded. Here at SANSA, in South Africa, there are two

magnetometers: a Magnetic Observatory fluxgate magnetometer and an unshielded SQUID magnetometer. The magnetometers are co-located in an area that is magnetically quiet as to not interfere with data collected by the magnetometers. In this project, the collected data from the SQUID magnetometer will be compared to the data from the fluxgate magnetometer. The SQUID is a relative instrument and not an absolute instrument, so calibration is required in terms of amplitude of the SQUID data as well as orientation of the SQUID axes. Currently, the main objective of the project is to calibrate the data from the SQUID so that it best matches the data from the fluxgate. Once that is accomplished, the next focus is to attenuate the environmental noise by creating an off the grid SQUID magnetometer. An off the grid SQUID magnetometer entails the use of a battery or a portable power source for the observation of the Earth's magnetic field.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 81 / **480**

Geomagnetic Storms Predictions

Author: Wayne Lester[1]

Co-authors: Mark Moldwin [2]; Rendani nndanganeni [3]

[1] *SANSA*

[2] *University of Michigan, USA)*

[3] *South African Nation Space Agency*

There have been many studies on the relationship between cosmic ray parameters and geomagnetic effects. This was an attempt to see if cosmic ray neutron monitor data can be used as a proxy for determining the space weather events and especially if there is any predictive information in neutron monitor data regarding geomagnetic storms. The premise is that cosmic ray neutron monitor data are modulated by shocks associated with Coronal Mass Ejections (CME) and the cosmic rays arrive at Earth before the CME. The goal of the project is to use neutron monitor data (from four neutron monitors in Southern Africa: Hermanus (oldest in the world), Potchefstroom, Sanae (Antarctica), and Tsumeb (Namibia)) in combination with the other standard geomagnetic activity parameters (Magnetic field readings, Solar wind data, and the Dst and Kp indices) to see if there exists a statistical relationship and whether this can be used as a proxy to predict the pre-geomagnetic storm conditions over southern Africa. If this is possible, this information would be used by the SANSA space weather prediction service to help mitigate against the harmful effects of geomagnetic storms on communications, navigation and power grid.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No

Poster Session 1 - Board: 82 / **481**

Wide angle mirror system design for distortionless imaging of the sky

Author: Hanna Vanwingen[1]

Co-authors: Mark Moldwin [1]; Michael Kosch [2]

[1] *University of Michigan, USA*

[2] *SANSA*

Imaging using all-sky lenses of 180° field of view has a long tradition in atmospheric airglow and auroral science. For a vertically mounted camera, the traditional fish-eye lens systems are linear in local zenith and azimuth angle. Hence, they introduce significant radial distortion, especially toward the horizon of the image. Fish-eye optics can be easily implemented using a single convex mirror or a pair of convex mirrors. A novel convex mirror shape that removes the fish-eye distortion from the image and keeps fixed resolution over the entire sky at a chosen altitude (e.g., 100 km) was developed in the early 90s. However, the local sky zenith in the image is blocked by the camera itself as it is situated looking down onto the mirror. We have solved this problem by using two convex mirrors with special profiles. However, this convex mirror system suffers from significant focusing issues. We use Snell's law of reflection, simple mathematics and straight-line ray tracing to design a corrected wide angle mirror system using two concave mirrors. The design provides a real time achromatic transform while implementing a uniform spatial sky resolution and optimizing focus throughout the field of view.

**Apply to be
 considered for a student
   award (Yes / No)?:**

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?:**

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?:**

No

Poster Session 1 - Board: 83 / **482**

A study of traveling ionospheric disturbances using GPS observations.

Author: Christopher Winkelmann[1]

Co-authors: John Bosco Habarulema [2]; Mark Moldwin [1]

[1] *University of Michigan, USA*

[2] *South African National Space Agency*

Traveling ionospheric disturbances are manifestations of atmospheric gravity waves and can be investigated using a number of data sources e.g., ionosonde and GPS receiver networks. Previous studies classified these disturbances as medium scale and large scale traveling ionospheric disturbances (TIDs) based on their characteristics which include velocities, amplitudes and directions. The propagation characteristics may also vary depending on the level of Earth-Space interactions and the strength of the magnetosphere-ionosphere coupling especially during disturbed conditions. Recent studies indicate that storm-induced TIDs mainly travel equatorward with the source origin being the auroral/high latitude zones. However other investigations reported that large scale TIDs of auroral origin from both hemispheres could travel further, cross the magnetic equator and hence travel

poleward. Very recent investigation confirmed an earlier proposed suggestion that the equatorial electrojet could also be a source of large scale TIDs. This project involves statistical analyses of traveling ionospheric disturbances during very quiet conditions in low latitude regions. This analysis will be aimed at establishing and quantifying the existence of ionospheric structures and their preferred direction of propagation using a historical data set.

**Apply to be
 considered for a student
   award (Yes / No)?**:

No

**Level for award
 (Hons, MSc,
   PhD, N/A)?**:

N/A

**Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?**:

No