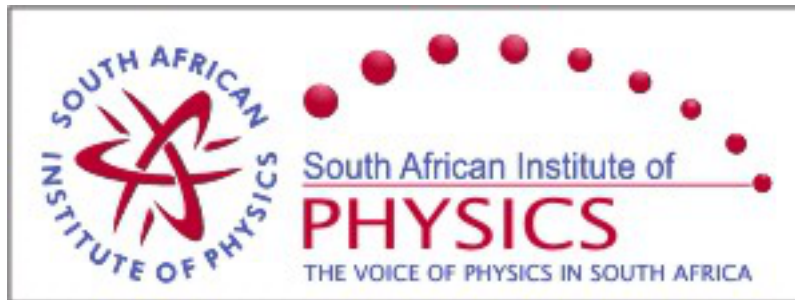


# SAIP2010

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## Book of Abstracts



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1

## **The Influence of dielectric parameters on the Reststrahlen region of SiC**

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The influence of dielectric parameters involved in the simulation of the reflectivity in the reststrahlen region of SiC is investigated as a possible cause for the appearance of an anomalous peak in this region of the reflectance spectrum of SiC. Results will be presented and discussed.

2

## **A Signature of Non-thermal X-ray Emission in AE Aquarii : Swift-XRT Data**

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**Co-author:** Pieter J. Meintjes <sup>1</sup>

<sup>1</sup> *University of the Free State*

Using X-ray data from the Swift satellite, we analysed the spectrum of AE Aqr and found that the emission has both thermal and non-thermal components. The latter shows up in the high energy spectral range, and its origin with respect to particle acceleration and synchrotron radiation will be discussed.

3

## **Accurate measurement of PV power under pulse width modulation**

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The monitoring of solar home systems is essential to improve the design and implementation of future systems. This paper discusses problems encountered in accurately measuring PV output power when monitoring systems using pulse width modulation charge controllers. Solutions to these problems are proposed and discussed and results presented.

4

## The Secret is in the Sauce

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The source region for whistlers has been hotly contested for many years. This study aims to show what fraction of lightning detected by WWLLN penetrates the ionosphere, and then to tie up individual fractional hop whistlers detected by the DEMETER satellite with whistlers observed on the ground at Tihany, Hungary.

6

## A Comparison of the tolerance of DQPSK, NRZ and RZ Modulation Formats in a PMD-induced Environment

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The design of modern wavelength-division-multiplexed (WDM) optical transmission systems has made advanced optical modulation formats a key ingredient. In this paper, we show PMD-induced system degradation through simulation. We found out that DQPSK is highly tolerant compared to RZ, however, RZ is more tolerant than NRZ.

7

## Field theoretical approach to dense polymer with clusters of Janus particles

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We propose a field theoretical approach to a polymer whose backbone is made of Janus particles. The field theory is solved using the saddle point approximation and the Random Phase Approximation valid for a dense polymer. We calculate the free energy density, the radius of gyration, and the Janus clusters concentrations.

8

## Performance of Foundation Physics students in First year university physics

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This paper reports on the role played by Foundation Physics course in preparing students for first year university physics. The performance of students who enrolled for and those who did not enroll for Foundation Physics after Grade 12 were compared in first year physics. 57 students who enrolled for Foundation Physics before and 107 students who did not enroll for Foundation Physics before first year physics wrote mechanics examinations and a mechanics questionnaire known as the Force Motion and Conceptual Evaluation. The results ind

9

## A Fundamental Description of Quarks using QCD and general relativity

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We develop a bound-state approach in quantum field theory which can be used to give an internal description of dressed quarks. The fermionic and bosonic fields are treated as interdependent. The quark is bound by self-consistent infinite binding potentials. By including general relativity and vacuum energy, we can stabilize this system. The average mass for the light quarks is 3.2 MeV, in remarkable agreement with experiment. The radius is 8.8 Planck lengths. These estimates only depend on the gravitational constant  $G$  and the Hubble constant  $H_0$

10

## Whistlers as a loss mechanism in the Earth's radiation belts

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**Co-authors:** Andrew Collier<sup>1</sup>; Steve Meyer<sup>1</sup>

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Lightning induced whistler waves are one of the primary drivers of energetic particle loss from the Earth's radiation belts. WWLLN data is used to create a model of the distribution of lightning in geomagnetic coordinates and derive the flux and spectrum of VLF whistler waves incident on the ionosphere.

11

## A Multivariate Study of Non-Simultaneous Forbush Decreases

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The distribution of the cosmic ray flux over the Earth is not uniform, but the result of complex phenomena within the Sun-Earth environment. A multivariate analysis of non-simultaneous Forbush decreases from an array of cosmic ray detectors will give an indication of the stations' asymptotic cones of acceptance.

12

## UV-enhancement in brightest cluster galaxies

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I will present results of an ongoing investigation of a large sample of brightest cluster galaxies (BCGs), their properties and the relationships between these and the properties of the host clusters. Here, we compare the stellar population properties derived from high signal-to-noise, optical long-slit spectra with the GALEX ultraviolet (UV) colour measurements for 36 nearby BCGs to understand the diversity in the most rapidly evolving feature in old stellar systems, the UV-upturn.

13

## Simulation studies of TIGRESS type Clover detector at iThemba LABS

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This work presents the results obtained from GEANT4 simulation study on TIGRESS type segmented HPGe detector. Unlike the usual Clover detector, TIGRESS detector has both longitudinal and lateral segmentation in each cylindrical crystal. The focus of the present study is to calculate the optimal later segmentation depth in the crystals.

15

## Satellite Imager Calibration and Validation

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The success or failure of any earth observation mission depends on the quality of its data. Data quality is assessed by determining the radiometric, spatial, spectral and geometric fidelity of the satellite sensor. The process is termed calval. This paper will describe calval techniques specific to South Africa.

17

## **Nuclear Reactor Core Reloads with OSCAR-4**

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Nuclear reactor core reload calculations are used to determine safety and operational parameters of a nuclear reactor. Accurately determining these parameters plays an important role in the safe operating of a reactor. The OSCAR-4 code was used to simulate reactor reloads, and the simulation results were compared to experimental plant data as verification of the simulation methods.

18

## **126 nm VUV emission from an Ar\*2 excimer lamp excited by a dielectric barrier discharge**

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**Co-authors:** Hubertus M. von Bergmann <sup>2</sup>; Timo Stehmann <sup>3</sup>

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A coaxial Ar excimer lamp excited by a dielectric barrier discharge has been developed and characterized. The effect of discharge gas pressure on the intensity of the Ar 126 nm VUV emission has been investigated. Intensity of the VUV Ar\*2 excimer emission increases with pressure according to a second order polynomial.

19

## **Electrical characterization of an Ar2\* excimer lamp excited by a dielectric barrier discharge**

**Author:** Peter Baricholo<sup>1</sup>

**Co-authors:** Hubertus M. von Bergmann <sup>2</sup>; Timo Stehmann <sup>2</sup>

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A bipolar pulsed high voltage and high frequency power supply has been developed to excite a dielectric barrier discharge excimer lamp. Voltage and current signals across the 5 mm electrode gap have been measured. Energy through the gas per pulse has been obtained by integrating the power applied. About 300  $\mu\text{J}$  of energy per pulse is delivered to the gas.

21

## Modelling of Eclipsing Binaries

**Author:** Patricia Skelton<sup>1</sup>

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The evolution of contact eclipsing binary stars is uncertain, but some systems undergo orbital period changes that may relate to physical changes in the system. Using ASAS and SuperWASP data, selected EC systems have been modelled using the WD code and an O – C period analysis.

22

## Spectral characterization of photovoltaic devices

**Author:** Willy Okullo<sup>1</sup>

**Co-authors:** Eugene van Dyk <sup>1</sup>; Frederik Vorster <sup>1</sup>; Mathew Munji <sup>1</sup>

<sup>1</sup> *Nelson Mandela Metropolitan University*

We investigated the effects of spectral variation on the performance of photovoltaic modules. To quantitatively correlate device performance to different spectra we measured current-voltage data, global irradiance and the corresponding spectrum at different times. This paper presents a detailed discussion of the correlation of device performance with incident spectrum.

23

## Solar cell parameter extraction from illuminated current-voltage data using particle swarm optimization algorithm

**Author:** Mathew Munji<sup>1</sup>

**Co-authors:** E.E. van Dyk <sup>1</sup>; Frederik Vorster <sup>1</sup>; Willy Okullo <sup>1</sup>

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Solar cell device parameters cannot be obtained directly from measured current-voltage (I-V) characteristics as performance parameters such as power output are, but need to be extracted by curve-fitting procedures. This contribution describes and applies a particle swarm optimization (PSO) algorithm to extract solar cell device parameters from I-V curves.

24

## Variation of device parameters of multi-crystalline silicon at defect regions

**Author:** Mathew Munji<sup>1</sup>

**Co-authors:** E.E. van Dyk<sup>1</sup>; Frederik Vorster<sup>1</sup>; Willy Okullo<sup>1</sup>

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A Solar-Light Beam Induced Current measurement system was used to identify defects regions in a multi-crystalline silicon cell. A particle swarm optimization algorithm was used to extract device parameters from current-voltage data to determine the variation of the device parameters of the cell at the defect locations.

25

## Effect of different ionospheric and ground conductivities on the propagation of VLF radio waves within the Earth-ionosphere waveguide

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**Co-author:** Andrew Collier<sup>1</sup>

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VLF (3-30 kHz) radio waves propagate with little attenuation within the Earth-ionosphere waveguide. There are numerous factors that determine waveguide propagation conditions such as ionospheric free electron density and the conductivity of the Earth's surface along the propagation path. This paper examines how modifications of these factors alter the propagation of the VLF waves.

26

## Particle simulations of space plasmas

**Author:** Etienne Koen<sup>1</sup>

**Co-author:** Andrew Collier<sup>2</sup>

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PIC simulations are numerical techniques for studying plasma phenomena which do not yield to an analytical solution. These techniques will ultimately be used to study chorus emissions which are whistler mode waves propagating through the Earth's magnetosphere. The two-stream instability is presented as an initial part of the study.

27

## **Luminescence from rare-earth doped silica prepared by the sol-gel method**

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**Co-authors:** Mart-Mari Duvenhage<sup>1</sup>; Martin Ntwaeaborwa<sup>1</sup>

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Silica doped with rare-earth ions was synthesized by the sol-gel method. The resulting powders were annealed at 600 and 1000°C. X-ray diffraction spectra indicated that all samples were amorphous. Samples doped with Tb<sup>3+</sup> exhibited the brightest luminescence, both when excited with UV light (photoluminescence) and with an electron beam (cathodoluminescence).

28

## **An Interferometric Method to Determine the Kerr Constant of Perspex**

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An adapted Michelson interferometric technique was used to measure strain induced birefringence in perspex. The birefringence was then used to determine the Kerr constant in perspex. The result obtained is compared to a polarimetric result and is shown to be a more sophisticated and reliable method.

29

## **An Atlas of Seyfert Galaxy Spectra**

**Author:** Hartmut Winkler<sup>1</sup>

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The author presents first results of a project to digitize and characterise the spectra of over 1000 Seyfert galaxies. Due to the already massive and growing size of the lists of known Seyferts, the project at this stage focuses on the following: (a) objects at redshifts of  $z < 0.1$ , and (b) Seyferts with a clearly visible broad-line component at H-beta. Standardised spectra are obtained from available electronic data as well as computer digitisations of spectral images. Basic spectral parameters are extracted from these spectra, and these are in turn categorised according to a new, sophisticated classification scheme.

30

## **Aerodynamics in arbitrarily accelerating frames: application to high-g turns**

**Author:** Irvy (Igle) Gledhill<sup>1</sup>

**Co-author:** Jan Nordström<sup>2</sup>

<sup>1</sup> CSIR

<sup>2</sup> FOI Sweden

Fifth-generation missiles accelerate up to 100 g in turns, and higher accelerations are expected as agility increases. We have developed the theory of aerodynamics for arbitrary accelerations, and have validated modelling in a Computational Fluid Dynamics code. In this paper we will show fin disruption by strake vortices.

31

## **Studying Chirality in Nuclei**

**Author:** OBED SHIRINDA<sup>1</sup>

**Co-authors:** ELENA ATANASSOVA LAWRIE<sup>2</sup>; LUKISI PAULUS MASITENG<sup>1</sup>; ROBERT LINDSAY<sup>3</sup>

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Characteristic conditions that should be met for two-quasiparticle chiral bands to reach degeneracy were examined using the two-quasiparticle-plus-rotor model for the  $A \sim 100, 130, 190$  mass regions. Previously proposed fingerprints of chirality (like intra- and inter-band B(M1) staggering, energy staggering, etc) were also studied.

32

## **Teachers working as a community of practice – Is it a viable alternative or a flat spare tyre?**

**Author:** Sam Ramaila<sup>1</sup>

**Co-authors:** Nair Padmanabhan<sup>1</sup>; Umesh Ramnarain<sup>1</sup>

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Various strategic interventions to enhance teacher professional development have been proposed over the years. Mentorship itself is a broad concept open to a variety of scholarly interpretations. This presentation reflects more specifically on the creative interaction amongst science teachers working as a community of practice with professional development efforts forming the nexus of this interaction which may, in turn, result in producing a ripple effect among the science teaching practitioners. Novice science teachers are the envisaged key beneficiaries of this creative partnership. Implications for long-term professional development of sc

34

## **The development of MOVPE InAs/GaInSb strained layer superlattice structures**

**Author:** Senzo Miya<sup>1</sup>

**Co-authors:** Johannes Reinhardt Botha<sup>2</sup>; Viera Wagener<sup>1</sup>

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InAs/GaInSb strained layer superlattice structures were discovered to have the same detectivities as HgCdTe ternary alloys of the same threshold energy at room temperature. This makes these superlattices suitable replacements for HgCdTe, which presents some technological difficulties. In this paper the optical and structural properties of GaInSb and GaInSb/GaSb quantum wells grown by metal-organic vapour phase epitaxy (MOVPE) are discussed.

35

## **Hydrothermally grown self-assembled ZnO nanorods on Si substrate**

**Authors:** OS Oluwafemi<sup>1</sup>; ZN URGESSA<sup>2</sup>

**Co-authors:** E.J Olivier<sup>2</sup>; JR Botha<sup>2</sup>

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Self assembled ZnO nanorods have been synthesized on seeded Si substrate by a simple hydrothermal route, using an ordinary glass beaker at a temperature of 750C. XRD analysis reveals that the as-grown rods have good crystalline quality and are c-axis oriented. SEM also confirms this orientation and shows single rods having hexagonal features and needle-like tips. Photoluminescence spectra showed strong UV excitonic emission and weak deep-level emission, which indicate good optical properties and very few structural defects.

36

## Determination of the Excess Charge Carrier Lifetime in Antimony Based Semiconductor Thin Films

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Steady state photo-conductivity measurements are used for the determination of the lifetime of excess charge carriers in antimony based semiconductor (i.e. Ga Sb) thin films. The spectral dependence of the lifetime, as well as the dependence of lifetime on the incident photon flux density, the temperature and the doping level is investigated. In order to evaluate the surface and bulk contributions to the lifetime, samples of different thicknesses, grown under the same conditions, are analyzed.

37

## Diffusion of fission products through silicon carbide

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**Co-authors:** Johan Malherbe<sup>1</sup>; Nic van der Berg<sup>1</sup>

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Fuel elements of modern high-temperature nuclear reactors are encapsulated by CVD-layers of pyrolytic carbon and silicon carbide to reduce fission product release. The aim of this study is to obtain information on volume and grain boundary diffusion as well as on the influence of radiation damage. For this purpose relevant isotopes were implanted in poly and single crystalline SiC samples at temperatures ranging from room temperature to 900 K. Diffusion coefficients were obtained from the broadening of the implantation profiles after isochronal and isothermal annealing studies up to 1900 K, using RBS analysis and electron microscopy.

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## SPIN-DENSITY-WAVE EFFECTS IN THE Cr-Al-Mo ALLOY SYSTEM

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Electrical resistivity and specific heat measurements on a (Cr<sub>98.5</sub>Al<sub>1.5</sub>)<sub>100-y</sub>Mo<sub>y</sub> alloy system are reported. The results indicate that antiferromagnetism is fully suppressed to below 2 K in alloys with y larger than 4.5 at.% Mo. The Sommerfeld electronic specific heat coefficient decreases sharply below this concentration.

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## Power-series expansion of the multi-channel Jost matrix

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For the Jost-matrix that describes the multi-channel scattering, the energy dependence at all the branching points on the Riemann surface is factorized analytically. The remaining single-valued matrix functions of the energy are expanded in the power-series near an arbitrary point in the complex energy plane. A systematic and accurate procedure has been developed for calculating the expansion coefficients. This makes it possible to obtain an analytic expression for the S-matrix near an arbitrary point on the Riemann surface and thus to locate the spectral points (bound and resonant states) as the S-matrix poles.

40

## Phase scintillation observed over a high-latitude Antarctic station

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In this paper, GPS transionospheric signals are used to study phase scintillation observations at the South African Antarctic polar research station. A multi-instrument approach shows that the scintillation events are associated with auroral electron precipitation. It is also demonstrated that substorms play an essential role in the production of scintillation in the high-latitude ionosphere.

41

## Multivariate Techniques for Constructing Quiet Day Curves

**Author:** Andrew Collier<sup>1</sup>

<sup>1</sup> *Hermanus Magnetic Observatory*

The identification of anomalies in time series data depends on a knowledge of the expected “normal” variations in the data. Numerous techniques exist for deriving such Quiet Day Curves (QDCs). A flexible multivariate technique has been developed which generates QDCs which account for seasonal and other variations.

42

## Sinusoidal Variation of Lightning Activity Over Africa

**Author:** Andrew Collier<sup>1</sup>

**Co-author:** Arthur Hughes<sup>2</sup>

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The annual cycle in lightning activity is driven by the seasonal variation in solar insolation which results from the passage of the Sun back and forth across the tropics. The annual lightning cycle for all countries in Africa is shown to decompose into annual and semi-annual components.

43

## Ab initio studies of staggered Li adatoms on graphene

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We study Li on graphene using the VASP code employing the PAW method within the GGA for the exchange-correlation. We give detailed structural and electronic results for various configurations involving Li on the different two-dimensional unit cells. For 100% coverage, we have new results for Li on the on-top site, which suggests a staggered configuration for the lowest energy structure for which the Li adatoms are alternately pushed into and pulled out of the graphene layer. For 50% coverage, Li favours the hollow site. We have discovered that a careful relaxation of the system also shows a staggered configuration of Lithium adatoms.

44

## Tunable Laser Based on Dye-Doped Polymer Gain Media Incorporating Nanoparticles: Novel Polymerization Method

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The solid state dye laser active medium prepared from Pyrromethene-567 dissolved in ethylene glycol and added in a 2-hydroxyethyl-methacrylate methyl-methacrylate (volume mixture 1:1) copolymerized by gamma irradiation method (GIM). This new method of processability, to the best of our knowledge, is the fastest way in fabricating Polymeric Dye Laser samples so far. In the present work, a cheap 3 Hz, 5 ns of energy 1mJ @ 571 nm laser output produced from Polymeric Dye Laser active medium by applying a compact air-cooled Nd:YAG laser-pumping technique has been designed and constructed. The optical setup of the present system is extremely simple

45

## Zero Outward Magnetic Flux From Surfaces Enclosing Non-dipolar Magnetic Sources

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<sup>1</sup> *Physics Department, Walter Sisulu University*

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In a harmonized representation of elemental field sources, those of magnetic fields are elemental magnetic vector charges. This permits a simple illustration that, unlike the gravitational and electric fluxes, the magnetic flux out of any closed surface is zero for any enclosed magnetic source, dipolar or non-dipolar.

46

## Tandem targetry possibilities for the production of the medically-important radionuclides <sup>88</sup>Zr and <sup>89</sup>Zr

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Excitation functions have been measured for the reactions <sup>89</sup>Y+p and <sup>93</sup>Nb+p and thick-target yield curves have been derived for the production of <sup>88</sup>Zr and <sup>89</sup>Zr up to 70 MeV. Tandem Nb/Y-targets as well as the extraction of medically-important radio-Zr nuclides from used Nb capsules as a by-product are discussed.

47

## On the design of a concentrator photovoltaic module

**Author:** Ross Schultz<sup>1</sup>

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Concentrated photovoltaic (CPV) modules are a cost effective alternative flat-plate photovoltaic modules that concentrate the sun onto small, highly efficient solar cells.[1] This paper addresses the design, and characterization of CPV modules that use 39% efficient triple junction solar cells. The optical, electrical and thermal configuration of the module is investigated.

48

## Monte Carlo simulation of Pt-Al binary alloy thin films

**Author:** Richard Harris<sup>1</sup>

**Co-authors:** E. Van der Lingen <sup>2</sup>; H.C. Swart <sup>3</sup>; J.J. Terblans <sup>3</sup>



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Pt-Al thin films (Pt25Al75, Pt55Al45 and Pt63Al37) were prepared and heat treated at various annealing-temperatures and times. Elemental maps and depth profiles were obtained with a PHI 700 nanoprobe. A chemical potential Monte Carlo model was developed and simulations were run. Theoretical depth-profiles and microstructures were obtained. Comparisons between experimental and theoretical results show good correlations.

49

## Vacuum Energies of Cosmic Strings

**Author:** Herbert Weigel Weigel<sup>1</sup><sup>1</sup> *Physics Department Stellenbosch University***Corresponding Author:** weigel@sun.ac.za

I present a computation of the fermion contribution to the vacuum polarization energy of string-like configurations in a non-Abelian gauge theory. I establish this method by numerically verifying the invariance under (a subset of) local gauge transformations. This also provides further support for the use of spectral methods to compute vacuum polarization energies in general. I confirm that the vacuum energy in the MS-bar renormalization scheme is much smaller than the mass of the fluctuating fermion field. Numerical results for the on-shell scheme are presented and the possibility of string stabilization via quantum effects is discussed.

50

## Comparative attenuation spectra of liquid skin-like phantoms

**Author:** Ann Singh<sup>1</sup>**Co-authors:** Aletta E. Karsten <sup>1</sup>; Ann F. Grobler <sup>2</sup>; Jacoba E. Smit <sup>1</sup>; Raymond W. Sparrow <sup>3</sup><sup>1</sup> *CSIR, National Laser Centre*<sup>2</sup> *Unit for drug development and research, North-West University, Potchefstroom, South Africa*<sup>3</sup> *CSIR, Biosciences***Corresponding Author:** asingh1@csir.co.za

This study aims to extract and compare attenuation coefficients of different liquid skin-like phantoms representing Skin Types I to VI with two methods, Spectrophotometric and Integrating Sphere methods. The correlation between the results of the 2 methods was excellent.

51

## A Far-IR Absorbing Molecule Showing Highest Molecular Second Order Nonlinear Optical Response: A Computational Study

**Author:** Sanyasi Sitha<sup>1</sup>

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We report, till date the highest value of molecular first hyperpolarizability (Second order Nonlinear Optical response) for an organic molecule. Calculation shows that low energy absorption (Far-IR) and large ground to excited state dipole difference, are mainly responsible for such a high value first hyperpolarizability even at the molecular level.

52

## Locating the inner edge of a neutron star crust

**Author:** Milton van Rooy<sup>1</sup>

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Neutron star properties are studied and the transition density from the core to the crust is calculated using fifteen parameter sets of the effective Skyrme nucleon-nucleon interaction, within a method called the dynamical method. Results are used to verify published values.

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## A perspective on additional structure in local formulations for position measurements in noncommutative quantum mechanics (NCQM)

**Author:** Chris Rohwer<sup>1</sup>

**Co-authors:** F. Scholtz<sup>2</sup>; K. Zloshchastiev<sup>2</sup>; L. Gouba<sup>2</sup>

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We contrast two equivalent formulations for NCQM position measurement: a constrained local description in position containing additional degrees of freedom, and an unconstrained nonlocal description without nonpositional degrees of freedom. After analysing corresponding classical theories, we demonstrate that the local formulations allow for natural interpretations of NCQM involving additional structure/extent.

54

## Ferromagnetic phase diagram of neutron matter

**Author:** J P W Diener<sup>1</sup>

**Co-author:** F G Scholtz<sup>2</sup>

<sup>1</sup> Stellenbosch University

<sup>2</sup> Stellenbosch University/NITheP

The magnetic properties of matter under extreme conditions are of particular importance to understand the neutron star interior. One contributing factor to the neutron star's magnetic field could be the ferromagnetic phase of nuclear matter. Using a relativistic model we calculated the ferromagnetic phase diagram for dense neutron matter.

55

## **Geomagnetic storms and solar sources relationships: a statistical analysis during solar cycle 23.**

**Author:** Jean UWAMAHORO<sup>1</sup>

**Co-author:** Lee-Anne McKinnell <sup>1</sup>

<sup>1</sup> Hermanus Magnetic Observatory

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Over a period of 11 years of solar cycle 23 : 1996-2006, the solar sources of 219 geomagnetic storms have been investigated . This investigation focused on a class of coronal mass ejections (CMEs) known as halo CMEs and they subsequent geo-effective conditions in the interplanetary medium. In this paper, we present the results of a statistical analysis of geomagnetic storms solar sources in terms of full halo and partial halo CMEs.

56

## **Selective Excitation of a Vibrational Level within the Electronic Ground State of a Polyatomic Molecule with Ultra Short Pulses**

**Author:** Ludwig De Clercq<sup>1</sup>

**Co-authors:** Anton Du Plessis <sup>2</sup>; Erich Rohwer <sup>3</sup>; Hermann Uys <sup>4</sup>; Lourens Botha <sup>2</sup>

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Coherent control of the upper vibrational level populations in the electronic ground state of a polyatomic molecule was simulated. Results indicate that selective excitation of a specific upper state level is possible.

57

## **A Quantum Hall Effect without Landau Levels in a Carbon Nanotube.**

**Author:** J D Brand<sup>1</sup>

**Co-author:** I Snyman <sup>2</sup>

<sup>1</sup> *Stellenbosch University*

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Inspired by known instances of a Quantum Hall Effect without Landau levels, we look for such an effect in a carbon nanotube subjected to a magnetic field that is constant along the axial direction and averages to zero around the tube's circumference.

58

## **Evidence for the early nucleation of single-walled carbon nanotubes**

**Author:** Mathew Moodley<sup>1</sup>

**Co-author:** Neil Coville <sup>2</sup>

<sup>1</sup> *CSIR*

<sup>2</sup> *University of the Witwatersrand*

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In situ optical emission spectroscopy(OES) was used to investigate the spatial and temporal evolution of the electron temperature( $T_e$ ) of laser induced plasmas in the laser-furnace method of synthesizing single-walled carbon nanotubes (SWCNTs). The intensities of the spectral maps of  $T_e$  showed a strong temperature dependence. The frequency of sharp fluctuations which appear as hot spots in the spectral maps of  $T_e$  increased as the furnace temperature was increased from 1073 K to 1273 K.

59

## **Expanding Entropy four-current up to third order in Dissipative Fluxes**

**Author:** fhumulani nemulodi<sup>1</sup>

**Co-author:** azwinndini Muronga <sup>1</sup>

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From Israel-Sterwart(second order) entropy four-current in kinetic theory, we expand it up to third order in dissipative fluxes, the Viscous stress tensor, heat flux and Viscous pressure. We show the temperature behaviour of our coefficients by plotting them as functions of temperature dependent parameter. Finally we will compare our results with those obtained from Israel-Sterwat theory.

60

## Nuclear Structure and Scattering in $^{20}\text{Ne}$ , $^{44}\text{Ti}$ , $^{94}\text{Mo}$ and $^{212}\text{Po}$

**Author:** Joram Ndayishimye<sup>1</sup>

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We investigate the nuclear structure and elastic scattering in nuclei ( $^{20}\text{Ne}$ ,  $^{44}\text{Ti}$ ,  $^{94}\text{Mo}$ , and  $^{212}\text{Po}$ ) using a model of alpha-cluster orbiting a closed shell core. A purely phenomenological cluster-core potential was found to provide a successful description of low lying positive parity spectra, electromagnetic transition strengths of these nuclei and alpha-decay rates of these states in  $^{212}\text{Po}$ . We then consider the same phenomenological potential as the real part of optical model to describe the differential elastic scattering cross-sections for the systems corresponding to  $^{20}\text{Ne} = ^{16}\text{O} + \alpha$ ,  $^{44}\text{Ti} = ^{40}\text{Ca} + \alpha$ ,  $^{94}\text{Mo} = ^{90}\text{Zr} + \alpha$ ,  $^{212}\text{Po} = ^{208}\text{Pb} + \alpha$ .

61

## Study of the time dependent modulation of galactic cosmic rays in the inner heliosphere

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**Co-author:** Stefan Ferreira<sup>1</sup>

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In this work a fully time-dependent cosmic ray model, based on the numerical solution of the Parker transport equation, is used to compute intensities of galactic cosmic rays in the heliosphere. Results are compared to recent observations of charged particles by the Ulysses spacecraft. We show how computed intensities along the Ulysses trajectory vary over a solar cycle and in particular show that it is possible to simulate cosmic ray modulation realistically during all the three fast latitude scan periods of the spacecraft.

62

## Z-dependent Bessel-like Beams

**Author:** Yaseera Ismail<sup>1</sup>

**Co-author:** Andrew Forbes<sup>1</sup>

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Bessel beams are generated by the propagation of plane waves along a conical surface. Experimentally such beams exist for a finite distance (near-field) however abruptly transforms into an annular ring (far-field). Here we outline a new optical method which allows a Bessel function to exist in the far-field as the propagation distance tends to infinity.

63

## Amplitude screening in solid-state laser resonators

**Author:** Darryl Naidoo<sup>1</sup>

**Co-authors:** Andrew Forbes<sup>1</sup>; Kamel Ait Ameer<sup>2</sup>; Marc Brunel<sup>3</sup>

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The oscillating mode in laser resonators is dual-directional between the mirrors. Theory describing the field distributions of the beam are compared and supplemented experimentally. The superposition of two Laguerre-Gaussian modes of opposite azimuthal order allows cylindrical “petal” modes to occur. These modes are achieved experimentally and compared to numerical simulations.

64

## Investigation into the effects of delamination in photovoltaic modules

**Author:** Jacqui Crozier<sup>1</sup>

**Co-authors:** Ernest van Dyk<sup>1</sup>; Frederik Vorster<sup>1</sup>

<sup>1</sup> *NMMU*

The mismatch of solar cell currents in a photovoltaic module has a substantial effect on the overall power output of the module. In this study the effects on cell mismatch were examined by characterizing a degraded Edge-defined Film-fed crystalline module and making a comparison with simulated results.

65

## The Integrating Sphere-based Setup as an Accurate System

**Author:** Shaimaa Abdalmonem<sup>1</sup>

<sup>1</sup> *National Institute for Laser Enhanced Science*

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Determination of the optical properties of solid and liquid samples has great importance. Since the integrating sphere-based setup is used to measure the amount of reflected and transmitted light by the examined samples, optical properties could be calculated. Our study is a preliminary step toward studying the optical properties of bacterial samples.

66

## Elemental composition analysis, morphological, and photoluminescence properties of pulsed laser ablated SrAl<sub>2</sub>O<sub>4</sub>:Eu<sup>2+</sup>, Dy<sup>3+</sup> thin films

**Author:** Patrick Nsimama<sup>1</sup>

**Co-authors:** Hendrik Swart<sup>2</sup>; Martin Ntwaeaborwa<sup>2</sup>

<sup>1</sup> *The university of the Free State*

<sup>2</sup> *The University of the Free State*

**Abstract:** SrAl<sub>2</sub>O<sub>4</sub>:Eu<sup>2+</sup>,Dy<sup>3+</sup> films ablated in different deposition atmospheres were characterized by Auger electron spectroscopy (AES), scanning electron microscopy (SEM), atomic force microscopy (AFM), and fluorescence spectrophotometer. Superior photoluminescence properties were recorded by films deposited in the different gas atmospheres. Surface morphology played a major role in the luminescent properties of the thin films. Electron degradation during prolonged electron bombardment was also monitored.

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## Collective Field Theory of Schur Polynomials

**Authors:** Robert de Mello Koch<sup>1</sup>; Stephanie Smith<sup>2</sup>

<sup>1</sup> *National Institute for Theoretical Physics and and Centre for Theoretical Physics*

<sup>2</sup> *University of the Witwatersrand*

We develop a collective field theory of single matrix models using the formalism of Jevicki and Sakita in [1] ('The Quantum Collective Field Method and its Application to the Planar Limit'), with Schur polynomials as collective fields. The highly nontrivial Jacobian associated with the change of variables required to obtain the collective field Hamiltonian, is found using group representation theory

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## The Distance to the Great Attractor

**Authors:** Blyth Sarah<sup>1</sup>; Tom Mutabazi<sup>1</sup>

**Co-author:** Patrick Woudt<sup>1</sup>

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Distance measurements to extragalactic sources are a major step towards studies in extragalactic astronomy. We here determine the redshift-independent distance to the Norma cluster, and hence the peculiar velocity in the Cosmic Microwave Background radiation rest frame using the Near-infrared Fundamental Plane for early-type galaxies.

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## Atomic Processes in Gaseous Nebulae

**Author:** Andri Prozesky<sup>1</sup>

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The physics of gaseous nebulae is critically examined using modeling software. Certain assumptions that are relevant for the optical spectral lines or low energy levels have been taken for granted to work for radio lines or transitions from high energy levels as well. The validity of these assumptions is tested.

70

## **Pulsation instability in Young Brown Dwarfs**

**Author:** Geoffrey Okeng'o<sup>1</sup>

**Co-author:** Enrico Olivier<sup>2</sup>

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We use a time-dependent model of turbulent convection which includes turbulent pressure, turbulent diffusion and turbulent viscosity to study stellar pulsations in young brown dwarfs recently proposed by Palla and Baraffe (2005). We find that turbulent pressure dominates in driving the oscillations with growth rates much higher than frozen-in approximation.

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## **Development of an emittance measurement device for the determination of the transverse phase space distribution of ion beams**

**Author:** Blaine Blaine B. D. Lomberg<sup>1</sup>

**Co-authors:** Lowry Lowry Conradie<sup>2</sup>; Rainer Rainer Thomae<sup>2</sup>

<sup>1</sup> *University of the Western Cape & iThemba LABS*

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In this paper we describe the development of a beam emittance device with which the quality of ion beams extracted from ion sources will be investigated.

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## **The K600 zero degree facility**

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**Co-authors:** A Richter<sup>2</sup>; A Tamii<sup>3</sup>; A.M. Heilmann<sup>2</sup>; C.O. Kureba<sup>4</sup>; D.T. Fourie<sup>1</sup>; E Sideras-Haddad<sup>4</sup>; E.Z. Buthelezi<sup>1</sup>; G.P.A Berg<sup>5</sup>; I Poltoratska<sup>2</sup>; I.T. Usman<sup>1</sup>; J. Carter<sup>4</sup>; J. Goerres<sup>5</sup>; J.A. Swartz<sup>6</sup>; J.J van Zyl<sup>6</sup>; J.L. Conradie<sup>1</sup>; J.P. Mira<sup>1</sup>; K Hatanaka<sup>3</sup>; M. Couder<sup>5</sup>; M. Jingo<sup>4</sup>; P Papka<sup>6</sup>; P. von Neumann-Cosel<sup>2</sup>; R.W. Fearick<sup>7</sup>; S O'Brien<sup>5</sup>; S.H.T. Murray<sup>1</sup>; S.V. Foertsch<sup>1</sup>; T Adachi<sup>8</sup>; Y Fujita<sup>9</sup>



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The K600 zero degree facility at iThemba LABS was recently successfully commissioned. The setup and experimental techniques for the high energy resolution measurement of (p,p') and (p,t) reactions at intermediate energies are described, and preliminary results are presented.

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## One loop anomalous dimension for a class of operators with bare dimension of $O(N)$

**Author:** Vincent De Comarmond<sup>1</sup>

**Co-authors:** Katherine Jefferies<sup>1</sup>; Robert de Mello Koch<sup>2</sup>

<sup>1</sup> *WITS*

<sup>2</sup> *WITS, National Institute for Theoretical Physics Stellenbosch*

For operators of bare dimension of  $O(N)$ , even in the large  $N$  limit the planar approximation is inaccurate. Here we study the anomalous dimension of operators built using two complex  $N$  by  $N$  matrices  $Z$  and  $Y$ . A basis for these operators, the restricted Schur polynomials, has been developed in [1]. The present study generalizes the work of [2], which considered operators built using no more than two  $Y$ s.

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## The Beam Quality Factor of Aberrated Gaussian Laser Beams

**Author:** Cosmas Mafusire<sup>1</sup>

**Co-author:** Andrew Forbes<sup>2</sup>

<sup>1</sup> *CSIR National Laser Centre*

<sup>2</sup> *CSIR National Laser Center*

A model is used to calculate the beam quality factor of a laser beam from Zernike coefficients. It is tested by programming aberration coefficients on a laser beam and measuring the beam quality using a Shack-Hartmann wavefront sensor. The two show excellent agreement.

75

## **Efficiency of different numerical techniques for evaluating global sensitivity indices when input variables are correlated and normally distributed**

**Author:** Bolade Adewale Adetula<sup>1</sup>

**Co-author:** Pavel .M Bokov<sup>2</sup>

<sup>1</sup> *Northwest university, NECSA*

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A recently developed sensitivity analysis technique known as Global Sensitivity Analysis (GSA) is based on the High Dimensional Model Representation and functional ANOVA. The efficiency of the different numerical techniques used in the evaluation for GSA, capable to deal with the curse of dimensionality and correlations between inputs, are evaluated.

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## **Geomagnetic survey towards the re-establishment of a magnetic observatory on Marion Island**

**Author:** Pierre Cilliers<sup>1</sup>

**Co-author:** Pieter Kotze<sup>1</sup>

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Marion Island (46d52.740'S, 37d51.442'E), near the edge of the South Atlantic Anomaly, is strategically located for geomagnetic observations. This paper presents the geomagnetic survey done on Marion Island towards the re-establishment of a magnetic observatory to follow up on observations done there during the period 1972 to 1980.

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## **An optical system to study temperature influenced chemical and mechanical changes to the PCD structure**

**Author:** Bathusile Masina<sup>1</sup>

**Co-author:** Andrew Forbes<sup>1</sup>

<sup>1</sup> *CSIR-National Laser Centre*

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In this investigation a polycrystalline diamond (PCD) body produced under High Pressure High Temperature (HTHP) conditions was heated using a CO<sub>2</sub> laser. The resultant surface temperature profile was measured optically by using the grey body emission from the PCD. This temperature measurement system allows one to study temperature influenced chemical and mechanical changes to the PCD structure.

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## Unveiling a massive overdensity behind Vela

**Author:** Kosma von Maltitz<sup>1</sup>

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Our understanding of local galaxy dynamics is hindered by the Milky Way which obscures a large fraction of the sky. I will present the latest evidence from a redshift survey of galaxies in the Vela region, behind the Milky Way, of the existence of a previously unknown overdensity.

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## Photo-transfection and selective optical differentiation of embryonic stem cells

**Author:** Patience Mthunzi<sup>1</sup>

**Co-authors:** Frank Gunn-Moore<sup>2</sup>; Kishan Dholakia<sup>2</sup>

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Due to their self-renewal and pluripotency characteristics, stem cells possess the potential to dramatically advance current therapies in tissue regeneration and engineering. In this work, we report for the first time that femtosecond laser pulses can be utilised for successful transient photo-transfection and differentiation of mouse embryonic stem cell colonies.

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## Theoretical description of quasielastic neutrino-induced strange particle production

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<sup>1</sup> *PhD Student in the area of Theoretical Nuclear Physics at Physics Department University of Stellenbosch*

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We present calculations of the quasifree associate production via the neutrino-nucleus weak interaction. Our formalism is done in the relativistic plane wave impulse approximation. In the plane wave limit, the spectator approximation is used to construct the invariant matrix element. The cross section is constructed as the contraction between the leptonic and hadronic tensors. The numerical results are generated based on the Born-term approximation. The distributions of the differential cross section with respect to various kinematical inputs are presented.

82

## Amplitude damping of vortex modes

**Author:** Angela Dudley<sup>1</sup>

**Co-authors:** Andrew Forbes<sup>1</sup>; Filippus Stef Roux<sup>1</sup>; Michael Nock<sup>2</sup>; Thomas Konrad<sup>2</sup>

<sup>1</sup> *CSIR National Laser Centre*

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An interferometer, mimicking an amplitude damping channel for vortex modes, is presented. Experimentally the action of the channel is in good agreement with that predicted theoretically. Since we can characterize the action of the channel on orbital angular momentum states, we propose using it to investigate the dynamics of entanglement.

83

## Affects of binary and continuous phase modulations on the structure of Bessel beams

**Author:** Angela Dudley<sup>1</sup>

**Co-authors:** Andrew Forbes<sup>1</sup>; Nikolai Khilo<sup>2</sup>; Piotr Ropot<sup>2</sup>; Ruslan Vasilyeu<sup>2</sup>; Vladimir Belyi<sup>2</sup>

<sup>1</sup> *CSIR National Laser Centre*

<sup>2</sup> *B.I. Stepanov Institute of Physics of NAS of Belarus*

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We implement a novel technique to operate a phase-only spatial light modulator (SLM) in amplitude mode, allowing us to reproduce Durnin's ring slit on a liquid crystal display (LCD). The affects of binary and continuous phase modulations on the structure of a zero-order Bessel beam is investigated.

84

## Strengthening the Output Power of an Optical Fiber Laser

**Authors:** Johan Meyer<sup>1</sup>; Josias Le Roux<sup>1</sup>; Rodolfo Martinez<sup>1</sup>

<sup>1</sup> *University of Johannesburg*

Theory on layout of a fiber laser, how a fiber laser operates and increasing the output power is covered in the paper. The steps followed to increase the output power are discussed, including the experimental results obtained.

85

## Investigating the rotation rates of superimposed Bessel beams

**Author:** Ronald Rop<sup>1</sup>

**Co-authors:** Andrew Forbes <sup>2</sup>; Angela Dudley <sup>2</sup>; Yaseera Ismail <sup>2</sup>

<sup>1</sup> *Moi University, Kenya*

<sup>2</sup> *CSIR National Laser Centre*

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In this work a spatial light modulator (SLM) and a ring slit are used to generate superpositions of higher-order Bessel beams. We show that even though these fields do not carry any orbital angular momentum (OAM) a rotation in their intensity profile is evident, agreeing well with the theoretical prediction.

86

## A New Representation for the Dilatation Operator at One Loop

**Author:** Katherine Jefferies<sup>1</sup>

**Co-authors:** Robert De Mello Koch <sup>2</sup>; Vincent De Comarmond <sup>1</sup>

<sup>1</sup> *University of the Witwatersrand*

<sup>2</sup> *University of the Witwatersrand & National Institute for Theoretical Physics, Stellenbosch*

The planar limit of the dilatation operator in the  $SU(2)$  sector has been studied extensively. In this presentation the exact one loop dilatation operator in the  $SU(2)$  sector will be considered. This is achieved by exploiting a new basis, the restricted Schur polynomial, which allows us to sum all higher genus diagrams.

87

## Evolution of the optical vortex density in phase corrected speckle fields

**Author:** Filippus Roux<sup>1</sup>

**Co-author:** Mingzhou Chen <sup>2</sup>

<sup>1</sup> *CSIR National Laser Centre*

<sup>2</sup> *Applied Optics, School of Physics, National University of Ireland-Galway*

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We numerically investigate the evolution of the optical vortex density in a speckle field after its continuous phase is removed, in other words, after it has been phase corrected. We found that it initially drops to 70% and then increases to 88% of the initial density. The rate of decrease is an order of magnitude faster than the rate of increase.

88

## Ionizing radiation as imaging tool for coal characterization and gasification research

**Author:** Jakobus Hoffman<sup>1</sup>

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<sup>1</sup> *Necsa*

<sup>2</sup> *North West University*

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Computer Tomography (CT) has been used extensively in the past to study a variety of samples including coal. This MSc-study will determine the validity of the CT technique specifically with regard to coal research by optimizing a general CT system, characterizing coal non-destructively and observing and studying the gasification process.

89

## Time resolved electron diffraction in Stellenbosch

**Author:** Kerstin Haupt<sup>1</sup>

**Co-authors:** Erich Rohwer<sup>1</sup>; Günther Kassier<sup>1</sup>; Heinrich Schwoerer<sup>1</sup>; Ilana Boshoff<sup>1</sup>; Nicolas Erasmus<sup>1</sup>

<sup>1</sup> *LRI, Stellenbosch University*

**Corresponding Author:** haupt@sun.ac.za

We will present the current status of our first time resolved electron diffraction experiment, which is the investigation of the structure change of an ultrafast heated thin metal foil. We will show how we produce the required freestanding metal films with a thickness of only a few tens of nanometers.

90

## Cathodoluminescence degradation of SrGa<sub>2</sub>S<sub>4</sub>:Ce<sup>3+</sup> powder phosphor

**Author:** Pulane Moleme<sup>1</sup>

**Co-authors:** Hendrik Swart<sup>1</sup>; Martin Ntwaeaborwa<sup>1</sup>

<sup>1</sup> *University of the Free State*

Cathodoluminescence (CL) of strontium thiogallate doped with cerium was investigated using Auger electron spectroscopy (AES) coupled with CL spectroscopy. The CL data were collected when the samples were irradiated with a beam of electrons accelerated at 1.5 to 2.5 kV. Possible mechanisms of CL degradation are discussed.

91

## Numerical simulation of decoherence of quantum entanglement through atmospheric turbulences

**Author:** Alpha Hamadou Ibrahim<sup>1</sup>

**Co-author:** Filippus Roux<sup>1</sup>

<sup>1</sup> CSIR, National Laser Centre

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A numerical procedure is proposed to study the decoherence of the entanglement between a pair of qubits due to atmospheric turbulence. The qubits are photons entangled in terms orbital angular momentum modes and the turbulent atmosphere is modeled with the von Karman-Tatarski spectrum.

92

## Ultrafast Electron Diffraction at Stellenbosch University

**Author:** Nicolas Erasmus<sup>1</sup>

<sup>1</sup> Stellenbosch University

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Femtosecond electron diffraction in principle allows for the observation of the initial dynamics of photo-induced processes in molecules and condensed phase with atomic spatial and temporal resolution. The method is based on the classical pump-probe spectroscopy with femtosecond laser pulses, but the difference being that the laser probe-pulse is replaced by an ultrashort electron pulse, which is diffracted off the target.

93

## Non-commutative Quantum Field Theory

**Author:** Hendrikus Groenewald<sup>1</sup>

**Co-authors:** F.G. Scholtz<sup>2</sup>; S.M. Wyngaardt<sup>1</sup>

<sup>1</sup> University of Stellenbosch

<sup>2</sup> National Institute for Theoretical Physics

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Non-commutative field theory is applied to nucleon-nucleon interactions where we assume the spatial coordinates of nucleons do not commute. This assumption leads to the interpretation that nucleons occupy a minimum volume in space which alters our view of NN-interactions. Qualitative descriptions of these interactions are obtained using various approximations.

94

## Overview of the Ultrafast Electron Diffraction Setup at Stellenbosch University

**Author:** Nicolas Erasmus<sup>1</sup>

<sup>1</sup> Stellenbosch University

**Corresponding Author:** nicolas.erasmus@gmail.com

Ultrafast electron diffraction is a new and exciting technique which aims to directly observe photo-induced dynamics of solids and molecules on the atomic level (spatially in the Ångström regime and temporally in the femtosecond regime). This is done by combining two tried-and-trusted techniques, namely static electron diffraction and femtosecond pump-probe spectroscopy.

95

## Characterization of Thulium Doped Fiber for Mid Infrared Laser Applications

**Author:** Wilfrid Ndebeka<sup>1</sup>

**Co-authors:** Alexander Heidt<sup>2</sup>; Erich Rohwer<sup>1</sup>; Henrich Schwoerer<sup>1</sup>

<sup>1</sup> *University of Stellenbosch*

<sup>2</sup> *University of Stellenbosch/ Institute of Photonic Technology, Albert-Einstein Jena (Germany)*

**Corresponding Author:** ndebeka@sun.ac.za

We present measurements of the slope efficiency and the pump power at threshold for a “triple-clad” thulium doped fiber laser, operating at around 2 μm wavelength. We observe fiber laser efficiencies as high as 47 % and output power of 5 W for 20 W of absorbed pump power. The dependence of the laser efficiency on different cooling methods will be discussed.

96

## Two-dimensional electronic spectroscopy

**Author:** Zephania Birech<sup>1</sup>

<sup>1</sup> *laser research institute, university of stellenbosch*

**Corresponding Author:** birech@sun.ac.za

A robust, inherently phase-stable Two-dimensional electronic spectroscopy setup employing conventional optics and delay stages is introduced. The setup is suitable for use in the ultraviolet, visible and near infrared spectral regimes.

97

## South African Space Weather Prediction Forecast

**Author:** Mpho Tshisaphungo<sup>1</sup>

**Co-author:** Kobus Olckers<sup>1</sup>

<sup>1</sup> *Hermanus Magnetic Observatory*

**Corresponding Author:** mtshisaphungo@hmo.ac.za

Space weather describes the conditions in space that affect both Earth- and Space bound technological and biological systems. It is a consequence of the behavior of the Sun, the nature of the Earth's



magnetic field and atmosphere, and our location in the solar system. Space weather is one of the principal threats to modern technology. With the increase in technological systems the need for accurate space weather predictions and forecasts has increased.

98

## **Laser pyrolysis at controlled laser power and wavelength for the synthesis of tungsten oxide nano-structures**

**Author:** Malcolm Govender<sup>1</sup>

**Co-authors:** Andrew Forbes<sup>1</sup>; Bonex Mwakikunga<sup>1</sup>; Elias Sideras-Haddad<sup>2</sup>; Lerato Shikwambana<sup>1</sup>

<sup>1</sup> CSIR

<sup>2</sup> University of the Witwatersrand

**Corresponding Author:** mgovender2@csir.co.za

This work demonstrates a versatile method known as CO<sub>2</sub>-laser pyrolysis which is used to synthesize high purity tungsten oxide thin films and nanostructures from gaseous-phase precursors. The results will show how laser pyrolysis can be used to control the phase and particle size of tungsten oxides by varying the laser power density and wavelength.

99

## **Analytical calculation of the microcanonical entropy in the anisotropic quantum Heisenberg model.**

**Author:** Gerrit Olivier<sup>1</sup>

<sup>1</sup> University of Stellenbosch

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The microcanonical entropy  $s(e,m)$  as a function of energy  $e$  and magnetization  $m$  is computed analytically for the anisotropic Heisenberg model with Curie-Weiss-type interactions for anti-ferromagnetic and ferromagnetic cases. The results show non-equivalence of ensembles for certain cases and thermodynamic equivalence to the Ising and Heisenberg models in other cases.

100

## **Comparison of two models for field enhanced emission through phonon assisted tunnelling using DLTS measurements**

**Author:** Jacques Pienaar<sup>1</sup>

**Co-authors:** Danie Auret<sup>1</sup>; Walter Meyer<sup>1</sup>

<sup>1</sup> University of Pretoria

**Corresponding Author:** jac\_pienaar@hotmail.com

Deep Level Transient Spectroscopy (DLTS) was used to measure the field enhanced emission rate from a defect introduced in n-type Ge. Nonlinear fits to the models of Pons & Makram-Ebeid (1979)

and Ganichev & Prettl (1997) which describe emission due to phonon assisted tunneling were obtained. The model of Pons & Makram-Ebeid predicted the measured emission rate more accurately than Ganichev & Prettl. Both models predicted a transition in the defect from a state of weak electron-phonon coupling to a state of strong electron-phonon coupling. Both models agree on the energy level of the defect and the apparent capture cross section.

101

## **Estimation of the parameters of the “neutron belt” of the COMETA setup using experimental data**

**Author:** Vusi Malaza<sup>1</sup>

<sup>1</sup> *Student*

**Corresponding Author:** mavoor@gmail.com

A study of a new type of nuclear transformation referred to as “collinear cluster tri-partition” (CCT) has been conducted. Reliable identification of this unusual decay channels involves measurement of neutron multiplicity. A new time-of-flight spectrometer called the Compact Multi-cluster Event Trigger Array (COMETA) has been designed to measure neutron multiplicity.

102

## **New concepts for broadband coherent supercontinuum generation in microstructured optical fibers and photonic nanowires**

**Author:** Alexander Heidt Heidt<sup>1</sup>

**Co-authors:** Alexander Hartung<sup>2</sup>; Erich Rohwer<sup>1</sup>; Hartmut Bartelt<sup>2</sup>

<sup>1</sup> *Laser Research Institute, Physics Department, University of Stellenbosch*

<sup>2</sup> *Institute of Photonic Technology*

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We numerically and experimentally investigate supercontinuum (SC) generation in fibers with all-normal group velocity dispersion (GVD) under femtosecond pumping, including photonic crystal fibers (PCF), photonic nanowires and suspended core fibers for octave-spanning recompressible supercontinuum generation in the infrared, visible and ultraviolet spectral regimes.

103

## **Characterising the Dwarf Novae Population**

**Author:** Deanne de Bude<sup>1</sup>

**Co-author:** Patrick Woudt<sup>1</sup>

<sup>1</sup> *University of Cape Town*

I present preliminary results of a follow-up study on Dwarf Novae identified by the Catalina Transient Survey. Photometric observations were performed on the 1m and 1.9m reflector telescopes of the South African Astronomical Observatory. The properties determined by this study are vital in understanding binary evolution and constraining binary synthesis models.

104

## Determination of shape and size of particles in porous media using tomography imaging

**Author:** Robert Nshimirimana<sup>1</sup>

**Co-authors:** Frikkie de Beer<sup>1</sup>; Radebe Mabuti<sup>1</sup>

<sup>1</sup> NECSA

**Corresponding Author:** robert.nshimirimana@necsa.co.za

The shape and size of particles are used in prediction of permeability (fluid conductivity) in porous media. This talk demonstrates the capability of a neutron/X-ray tomography imaging system in determination of the shape and the size of particles non-destructively.

106

## Probing the fine structure of the giant quadrupole resonance in <sup>28</sup>Si using hadronic and leptonic reactions

**Author:** Iyabo Usman<sup>1</sup>

**Co-authors:** A Richter<sup>2</sup>; A Shevchenko<sup>2</sup>; E Sideras-Haddad<sup>3</sup>; F.D Smit<sup>1</sup>; G.R.J Cooper<sup>4</sup>; H Fujita<sup>1</sup>; J Carter<sup>3</sup>; P von Neumann-Cosel<sup>2</sup>; R Neveling<sup>1</sup>; R.W Fearick<sup>5</sup>; S.V Förtsch<sup>1</sup>; Y Fujita<sup>6</sup>; Y Kalmykov<sup>2</sup>; Z Buthelezi<sup>1</sup>

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The comparison of proton inelastic scattering from <sup>28</sup>Si with data from other probes exciting the Isoscalar Giant Quadrupole Resonance (ISGQR) is investigated. Wavelet coefficients of the ISGQR for the various probes are compared to that of (p,p') using the newly-developed Semblance and Dot product techniques.

107

## The Effect of Different Diode Laser Powers in Photodynamic Therapy

**Author:** Kaminee Maduray<sup>1</sup>

<sup>1</sup> CSIR

**Corresponding Author:** kmaduray@csir.co.za

This preliminary photodynamic therapy study investigated the effect of different diode laser powers (mW) for the activation of two photosensitizers (AlTSPc, aluminum tetrasulfonatedphthalocyanine and ZnTSPc, zinc tetrasulfonatedphthalocyanine) in healthy normal fibroblast cells.

108

## MTR Reflector Modelling making use of Equivalence Theory

**Author:** Suzanne Theron<sup>1</sup>

**Co-author:** Frederik Reitsma<sup>2</sup>

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This research focuses on modelling reflectors in typical material testing reactors (MTRs). Equivalence theory is used to homogenise and collapse detailed transport solutions to generate equivalent nodal parameters and albedo boundary conditions, for subsequent use in full core diffusion codes. This study aims to determine if this approach to MTR reflector modelling is an accurate and plausible homogenisation technique for the modelling of small MTR cores.

109

## Probing the super star cluster luminosity function in interacting luminous infrared galaxies

**Author:** Zara Randriamanakoto<sup>1</sup>

**Co-authors:** Petri Vaisanen<sup>2</sup>; Seppo Mattila<sup>3</sup>; Stuart Ryder<sup>4</sup>

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<sup>2</sup> South African Astronomical Observatory

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From a deep NIR adaptive optics imaging survey, we present thus-far the first K-band super star cluster (SSC) luminosity function (LF) to probe the formation and evolution of SSCs. Based on the derived LF one can constrain the cluster initial mass function (CIMF). Our preliminary results are in disagreement with theoretical expectations which suggest that SSC LFs should be well fitted by a single power law  $-2$ . We get power-law indices much shallower than the theoretically expected one.

110

## Luminous Red Galaxies in Simulations: Cosmic Chronometers?

**Author:** ANDO RATSIMBAZAFY<sup>1</sup>

**Co-authors:** Catherine Cress<sup>1</sup>; Enrico Olivier<sup>2</sup>; Kurt van der Heyden<sup>3</sup>; Sarah Blythe<sup>3</sup>; Steve Crawford<sup>2</sup>

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The expansion rate of the Universe can potentially be measured using age-dating of Luminous Red Galaxies (LRGs). We explore the validity of the assumptions implicit in this method using LRGs identified in the Millenium Simulation (MS). We use stellar population modelling and spectral synthesis to estimate the errors on ages that can be expected and discuss optimization of such an experiment. We find that  $H(z)$  using simulated galaxies can be recovered with high accuracy. Using single stellar populations to age-date LRGs is not sufficient but if the MS star formation histories of galaxies are used, accurate ages are obtainable.

111

## Electric field induced second harmonic generation from silicon/silicon dioxide interfaces of silicon membranes

**Author:** Gibson Peter Nyamuda<sup>1</sup>

**Co-authors:** Christine Steenkamp<sup>1</sup>; Erich Rohwer<sup>1</sup>; Herbert Stafast<sup>2</sup>

<sup>1</sup> Stellenbosch University

<sup>2</sup> Institute of Photonic Technology

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A femtosecond laser is used to study second harmonic generation in reflection and for the first time in transmission using a silicon membrane sample. The second harmonic signal measured in transmission is higher than expected and a new interpretation of second harmonic generation results from silicon/silicon dioxide interfaces is proposed.

112

## Optimization of the laser pyrolysis parameters to synthesis vanadium oxide (VO<sub>2+x</sub>) nanostructures

**Author:** Lerato Shikwambana<sup>1</sup>

**Co-authors:** Andrew Forbes<sup>1</sup>; Bonex Mwakikunga<sup>1</sup>; Elias Sideras-Haddad<sup>2</sup>; Malcolm Govender<sup>1</sup>

<sup>1</sup> CSIR-NLC

<sup>2</sup> University of the Witwatersrand

A laser pyrolysis (LP) technique was used to synthesis VO<sub>2+x</sub> nanostructures at a wavelength of 10.6  $\mu\text{m}$  and power density of 2.4 kW/cm<sup>2</sup>. Scanning electron microscopy (SEM) showed nano-rods with lengths of 185 nm and diameters of 53 nm. Energy dispersive x-ray (EDX) analysis established the presence of vanadium oxide.

113

## Linear and non-linear regression modelling of TEC

**Author:** John Bosco Habarulema<sup>1</sup>

**Co-authors:** McKinnell Lee-Anne<sup>1</sup>; Opperman Ben<sup>2</sup>

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This paper compares both linear and non-linear regression modeling techniques in approximating total electron content (TEC). Both techniques have been applied on a similar dataset and verified on an independent but identical dataset to assess the performance of the developed models

114

## Spectroscopic studies of nano NaYF<sub>4</sub> doped with RE<sup>3+</sup> synthesized via thermal decomposition of organic precursors.

**Author:** Marek Gusowski<sup>1</sup>

**Co-author:** Hendrik Swart<sup>1</sup>

<sup>1</sup> *Department of Physics University of the Free State*

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The structural and luminescence properties of sodium yttrium fluoride (NaYF<sub>4</sub>) nanoparticles co-doped with rare earth ions, prepared using a thermal decomposition of fluoracetates precursors, were investigated. Luminescent NaYF<sub>4</sub>:Er<sup>3+</sup> nanoparticles in the range of 8-30 nm were obtained.

115

## Time dependent reflectivity from a silicon/silicon dioxide interface observed by pump-probe technique

**Author:** Gibson Peter Nyamuda<sup>1</sup>

**Co-authors:** Christine Steenkamp<sup>1</sup>; Erich Rohwer<sup>1</sup>; Herbert Stafast<sup>1</sup>

<sup>1</sup> *Stellenbosch University*

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Stationary, single colour, pump-probe reflectivity measurements were performed for the first time on the silicon/silicon dioxide interface of n-type silicon using a femtosecond laser. The change in the reflected probe beam increased with time of several minutes during irradiation of the sample with a strong pump beam.

116

## Existence domains of ion-acoustic and electron-acoustic solitons in two-electron temperature space plasmas

**Author:** Shimul Kumar Maharaj<sup>1</sup>

**Co-authors:** Gurbax Lakhina<sup>2</sup>; Ramesh Bharuthram<sup>3</sup>; Sadha Pillay<sup>4</sup>; Satyavir Singh<sup>2</sup>

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<sup>2</sup> *Indian Institute of Geomagnetism*

<sup>3</sup> *University of the Western Cape*

<sup>4</sup> *School of Physics, University of KwaZulu-Natal (Westville Campus)*

Using the Sagdeev pseudo-potential formalism, the permitted velocity ranges of large amplitude ion-acoustic and electron-acoustic solitons are determined for a plasma comprised of hot and cool electrons, and ions. Adiabatic fluids are used for the cool electrons and the ions, whereas, for the hot electrons, both the cases corresponding to including inertial effects and neglecting the inertia by using the Boltzmann assumption for the hot electron number density, will separately be investigated.

117

## Relativistic description of nucleon-nucleus scattering with DWIA and RPA

**Authors:** Brandon Van der Ventel<sup>1</sup>; David Van Niekerk<sup>1</sup>

**Co-author:** Nortin Titus<sup>1</sup>

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We have formulated a fully relativistic model for inclusive quasielastic nucleon-nucleus scattering. Using RIA we show how the behaviours of projectile and target can be separated into two independent tensors. Subsequently we investigate the RPWIA as well as DWIA descriptions of the projectile. We also examine the Hartree and the RRPAs responses of the target.

118

## Inverse Compton gamma-ray production in Be-pulsar binary systems

**Author:** Brian van Soelen<sup>1</sup>

**Co-author:** P. J. Meintjes<sup>1</sup>

<sup>1</sup> *University of the Free State*

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The effect of the infrared excess on inverse Compton gamma-ray production in the pulsar binary system PSR B1259-63/SS 2883 is considered. The infrared excess is calculated using catalogue observations and the exact Compton cross-section is used to calculate the expected gamma-ray spectra for an isotropic distribution of target photon.

119

## Formation of Cubic Boron Nitride Nanoparticles by Boron and Lithium Ion Implantation

**Author:** Emily Aradi<sup>1</sup>

**Co-authors:** Rudolph Erasmus<sup>2</sup>; Trevor Derry<sup>2</sup>

<sup>1</sup> *University of the Witwatersrand*

<sup>2</sup> *University of the Witwaterstand*

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The structural modification of polycrystalline hexagonal boron nitride implanted with boron and lithium ions at 150keV with various fluences were investigated. This was accomplished by analysis with Raman spectroscopy before and after implantation. Micro-Raman Spectrum showed evidence of implantation induced transformation to c-BN. The shifting of c-BN peak was explained using the phonon confinement model.

120

## Astrophysical Masers

**Author:** Michael Gaylard<sup>1</sup>

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The laser was invented 50 years ago, but it was preceded six years earlier by the maser - stimulated emission at microwave frequencies - invented by Charles Townes and colleagues. Although it was not known at the time, nature had beaten them to it. Naturally produced masers are found in space, the first being discovered in 1965 by Weaver and colleagues. These masers occur in clouds of gas and dust in which stars are forming, in clouds around some evolved stars, and near the nuclei of certain galaxies. I shall briefly review natural masers and describe some of the current research that makes use of their properties.

121

## Characterization of a Low Concentrator Photovoltaic Module

**Author:** Eugene van Dyk<sup>1</sup>

**Co-authors:** Blake Butler<sup>1</sup>; Frederik Vorster<sup>1</sup>; Mathew Munji<sup>1</sup>; Willy Okullo<sup>1</sup>

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Concentrator photovoltaic deals with the focussing of incident sunlight onto solar cells by employing relatively inexpensive optical elements in an attempt to reduce overall photovoltaic system cost. In this study a low concentrator photovoltaic module was designed and constructed to characterize the optics, electrical performance and thermal management.



122

## Nucleotide Binding to Adenylate Kinase (AK) 1: Effect of Deuteration.

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The binding activity of AK1 enzymes in the presence of ATP and deuterated ATP were measured using CD spectroscopy. The data showed conformational changes occurring on the binding of these nucleotides and provided an insight into the possible dynamics of these changes.

123

## COVARIANT GAUGE-INVARIANT PERTURBATIONS IN MULTI-FLUID $f(R)$ THEORIES OF GRAVITY

**Authors:** Amare ABEBE<sup>1</sup>; MOHAMED ABDELWAHAB<sup>1</sup>

**Co-author:** Peter Dunsby<sup>1</sup>

<sup>1</sup> *uct*

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In this paper we studied multi-fluid perturbations to fourth order theories of gravity in a FLRW background. applying the 1+3 covariant gauge-invariant formalism of cosmological perturbations and derive a complete set of evolution equations for matter and curvature inhomogeneities. We then specialize to a radiation-dust fluid described by barotropic equations of state and apply the perturbation equations around a background solution of  $R_n$  gravity and look at exact solutions for scales much smaller and much larger than the Hubble radius. In particular, we analyze quasi-static approximations and show the analytic solutions of these approximation.

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## Ex situ synthesis and optical properties of ZnO-PbS nanocomposites

**Author:** Pontsho Sylvia Mbule<sup>1</sup>

**Co-authors:** Hendrik Swart<sup>1</sup>; Martin Ntwaeaborwa<sup>1</sup>; Ted Kroon<sup>1</sup>

<sup>1</sup> *University of the Free State*

Abstract: Zinc Oxide (ZnO) and lead sulphide (PbS) nanoparticles separately synthesized by a precipitation method were combined by an ex situ route to prepare ZnO-PbS nanocomposites with different molar ratios of ZnO and PbS. Optical properties, structure and morphology of the samples were analyzed and are discussed.

125

## Efficiency Study of Solar Trough Receiver

**Author:** Marie Chantal CYULINYANA<sup>1</sup>

**Co-author:** Philippe Ferrer<sup>2</sup>

<sup>1</sup> *University of the Witwatersrand*

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We are considering a solar trough system, with the receiver pipe enclosed in a glass cover under vacuum. We present results for absorption and loss calculations for a general case, and use these to compare two scenarios: 1) receiver pipe is coated with a selective coating, and 2) glass cover is coated with a hot mirror coating. Simulations for both scenarios are presented and compared.

126

## Utilise the (In)visible to Reveal the Hidden

**Author:** Frikkie De Beer<sup>1</sup>

**Co-authors:** Jacob Radebe<sup>1</sup>; Kobus Hoffman<sup>1</sup>; Robert Nshimirimana<sup>1</sup>

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Several invisible phenomena, which are part of our daily lives, are being used consciously or non-consciously to reveal features hidden from eyesight. One such phenomena is penetrating radiation in the form of neutrons, gammas- or X-rays which are continuously being utilized to reveal hidden features, unseen and undetected by the normal human eye of e.g. precious artifacts, fossils and the human body through radiography and tomography. The basic concepts and unique applications of these processes to unwrap the hidden are being discussed and outlined – not to be missed

127

## Observing mesospheric gravity waves with an imaging riometer in SANAE

**Author:** Bhekumuzi Sfundo Khanyile<sup>1</sup>

<sup>1</sup> *University of Fort Hare*

**Corresponding Author:** sfundob@gmail.com

We present the characteristics of small scale (< 100 km) gravity waves in the lower and upper atmosphere derived from imaging riometer at SANAE (710 S, 20 W). FFT technique is used to extract wave parameters of the gravity waves. These waves have horizontal phase speed of 0-250 m/s, horizontal wavelength of 16-30 km and the period of 3-30 min. And the propagation direction is ~ 50 degrees.

128

## **Multiwavelength Study of Supersoft X-ray Sources in Magellanic Clouds**

**Author:** Alida Odendaal<sup>1</sup>

**Co-author:** Pieter Meintjes<sup>1</sup>

<sup>1</sup> *University of the Free State*

Supersoft X-ray sources constitute a fascinating class of X-ray systems. Some of these sources consist of a compact object accreting material from a binary companion. The analysis of X-ray and optical spectra discloses valuable information on the exact nature and temporal variation of the extremely powerful physical processes involved.

129

## **Laser Cooling and Trapping of Ultra-cold Rubidium Atoms**

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An experimental setup for laser cooling and trapping of neutral rubidium atoms is being developed. A three dimensional optical molasses in a Maxwell gradient magnetic field is used. The effects of the trap parameters on the number of trapped atoms will be investigated. The current status and recent results are presented.

130

## **Spica: Custom data acquisition and control software for the Boyden research telescopes.**

**Author:** Hendrik Jacobus van Heerden<sup>1</sup>

**Co-authors:** J.J. Calitz<sup>2</sup>; J.J. Terblans<sup>1</sup>; P.J. Meintjes<sup>1</sup>

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The development of Spica, a custom designed data acquisition and control software package for the Boyden research telescopes will be considered. The motivation for the development of the package as well as the aims and capabilities of the software in terms of the hardware-software interfacing, and the data acquisition and control will be discussed. Results on the implementation and uses will be shown.

131

## **Selective deactivation of M13 bacteriophage in E. coli using femtosecond laser pulses.**

**Author:** Palesa Molukanele<sup>1</sup>

**Co-authors:** Anton Du Plessis<sup>1</sup>; Lourens Botha<sup>1</sup>; Makobetsa Khati<sup>1</sup>; Ted Roberts<sup>1</sup>; Walter Campos<sup>1</sup>

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Potential for the selective deactivation of viruses while leaving the sensitive material such as the host cell unharmed was studied using a femtosecond laser system, and preliminary results will be reported.

132

## **Amplitude modulation using a phase only Spatial Light Modulator**

**Author:** Attie Hendriks<sup>1</sup>

**Co-authors:** Andrew Forbes<sup>1</sup>; Filippus S. Roux<sup>1</sup>

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Theory presenting amplitude and phase modulation using a phase only spatial light modulator is proposed and experimentally verified. This allows manipulation of any arbitrary light distribution unto developing a transmission function toolbox for quantum experiments.

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## **Contribution Towards Achieving International Standards for Neutron Imaging.**

**Author:** Mabuti Jacob Radebe Radebe<sup>1</sup>

**Co-authors:** Elias Sideras-Haddad<sup>2</sup>; Frikkie De Beer<sup>1</sup>; Gawie Nothnagel<sup>1</sup>; John Watterson<sup>2</sup>; Robert Nshimirimana<sup>1</sup>

<sup>1</sup> Necsa

<sup>2</sup> University of Witwatersrand

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Neutron imaging is a powerful analytical tool with potential and demonstrated industrial and research application to nondestructively investigate internal properties of matter or end products. Standards, through test samples and methods, are essential for industrial application and internationally uniform platform for practice and facility performance assessment. This PhD subproject is a contribution towards establishment of international standards for digital neutron imaging.

134

## **Three wavelength SCALLS setup for analysis of crystallization and particle size estimation**

**Author:** Pieter Neethling<sup>1</sup>

**Co-authors:** Albert van Reenen<sup>2</sup>; Erich Rohwer<sup>1</sup>; Margaretha Brand<sup>2</sup>; Piet Walters<sup>1</sup>

<sup>1</sup> *Laser Research Institute, University of Stellenbosch*

<sup>2</sup> *Department of Chemistry and Polymer Science, University of Stellenbosch*

**Corresponding Author:** pietern@sun.ac.za

A SCALLS (Solution Crystallization Analysis by Laser Light Scattering) setup has been improved using 3 lasers with different wavelengths. This improvement allows us to not only determine the temperatures at which crystallization starts to occur, but also to estimate the size of the crystallites (as a function of temperature).

135

## **Luminescence properties of Ce<sup>3+</sup> and Tb<sup>3+</sup> –doped ZnAl<sub>2</sub>O<sub>4</sub> phosphors prepared by combustion reaction**

**Author:** Kamohelo George Tshabalala<sup>1</sup>

**Co-authors:** Hendrik Swart<sup>1</sup>; Jong-Ku Park<sup>2</sup>; Nagpure Indrajit<sup>1</sup>; Odireleng Martin Ntwaeaborwa<sup>1</sup>; Pitale Shreyas<sup>1</sup>; SoHye Cho<sup>2</sup>

<sup>1</sup> *University of the Free State*

<sup>2</sup> *Korea Institute of Science and Technology*

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Cerium- and terbium –doped zinc aluminate oxide nanocrystals with a spinel structure were successfully prepared by a combustion method, using urea as fuel. The solid combustion products thus obtained were identified by their characteristic XRD patterns. The fine-particle nature of these powders was investigated using SEM, TEM, and luminescence spectroscopy

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## **An Ultrafast Study of Zinc Phthalocyanine in DMSO**

**Author:** Saturnin OMBINDA-LEMBOUMBA<sup>1</sup>

**Co-authors:** Anton du Plessis<sup>2</sup>; Lourens Botha<sup>1</sup>

<sup>1</sup> *CSIR National Laser Centre*

<sup>2</sup> *CSIR National Laser centre*

**Corresponding Author:** sombinda@csir.co.za

The ultrafast dynamics of Zinc Phthalocyanine was studied using transient absorption pump probe spectroscopy. Zinc Phthalocyanine was excited (pumped) at 672nm and probed by a white light continuum. The pump-probe technique used in this study is described and experimental results obtained are discussed.

137

## Biophysics and its promising contribution to South African Physics

**Author:** Tjaart Krüger<sup>1</sup>

<sup>1</sup> *VU University Amsterdam*

We present a very brief introduction to biophysics – the rapidly developing field that explores physical processes in biological systems – and emphasise the great variety of spectroscopic techniques and applications. The promising role that biophysics can and should play in the context of South African Physics is briefly described.

138

## The effect of sulphur-based treatment on the quality of GaSb surfaces

**Authors:** A Venter<sup>1</sup>; Davison Munyaradzi Murape<sup>1</sup>

**Co-authors:** HC Swart<sup>2</sup>; JR Botha<sup>1</sup>

<sup>1</sup> *NMMU*

<sup>2</sup> *UFS*

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The effect of sulphur treatment on the electrical and optical properties of Te doped bulk n-GaSb has been studied by current-voltage (IV), capacitance-voltage (CV), photoluminescence (PL) and X-Ray photo-spectroscopy (XPS). Treating the GaSb surface with Na<sub>2</sub>S·9H<sub>2</sub>O, (NH<sub>4</sub>)<sub>2</sub>S and (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> resulted in an improvement in the reverse leakage current of up to an order of magnitude for Au/n-GaSb Schottky barrier diodes (SBDs) while an increase in the photoluminescence intensity was also observed. XPS of the sulphur treated surfaces suggest that S<sup>2-</sup> ions interact with the degenerate GaSb surface resulting in its partial stabilization.

140

## Collisional dynamics of ultracold polar molecules in a microwave field

**Author:** Alexander Avdeenkov<sup>1</sup>

<sup>1</sup> *NIThep, Stellenbosch University*

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The collisions at ultracold temperatures between diatomic polar molecules in a microwave field with a circular polarization are theoretically analyzed. We demonstrate the possibility of trapping polar molecules in the standing-wave electromagnetic field and a successful evaporative cooling not only for samples of molecules in their absolute ground states but in some rotationally excited states in the appropriate regions of frequencies of a field.

141

## Search for the Giant Pairing Vibration via (p,t) reactions around 60 MeV

**Author:** Siegfried Förtsch<sup>1</sup>

**Co-authors:** A. Ramus<sup>2</sup>; B. Mouginot<sup>2</sup>; E. Khan<sup>2</sup>; E.Z. Buthelezi<sup>3</sup>; F. Azaiez<sup>2</sup>; F.D. Smit<sup>3</sup>; H. Fujita<sup>4</sup>; I. Stefan<sup>2</sup>; I.T. Usman<sup>4</sup>; J. Mabilia<sup>5</sup>; J.A. Scarpaci<sup>2</sup>; J.A. Swartz<sup>5</sup>; J.P. Mira<sup>6</sup>; R. Neveling<sup>3</sup>; S. Franchoo<sup>2</sup>

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A Giant Pairing Vibration (GPV) is a collective mode involving two-neutron transfer. This mode which is of fundamental importance, since it is analogous to a giant resonance in the particle-particle channel, has however not yet been detected and important uncertainties concerning its cross section, width and position remain.

142

## Luminescence studies of CaQ2 organic phosphor for OLED applications

**Author:** Indrajit Nagpure<sup>1</sup>

**Co-authors:** Martin Ntwaeaborwa<sup>1</sup>; SS Pitale<sup>1</sup>; Vinay Kumar<sup>1</sup>

<sup>1</sup> *University of the Free State*

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UV photo-excited luminescence from CaQ2 organic phosphors and PMMA based thin films for OLED application has been investigated. The intense emission of the spectrum is assigned to the complex polymer network of the Ca ions in the 1-8 hydroxyl quinoline networks. CaQ2 phosphor was synthesized by the co-precipitation method. The FTIR and photoluminescence (PL) characterization of the phosphors are reported in this paper.

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## Atomistic Simulation Studies of Lithiated MnO2 Nanostructures

**Author:** Kenneth Kgatwane<sup>1</sup>

**Co-authors:** Dean Sayle<sup>2</sup>; Phuti Ngoepe<sup>1</sup>; Regina Maphanga<sup>1</sup>

<sup>1</sup> *University of Limpopo*

<sup>2</sup> *Cranfield University*

**Corresponding Author:** kगतwanek@hotmail.com

MnO<sub>2</sub> has found extensive applications as a cathode material in lithium batteries. However MnO<sub>2</sub> suffers from structural degradation during charge/discharge which leads to capacity fading. We use atomistic simulation to explore and mitigate this structural collapse by employing novel porous MnO<sub>2</sub> nanostructures with defects. The nanostructures are lithiated to simulate charge/discharge.

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## **Minimisation using MERLIN on the seismic wave equation for the recovery of material properties in 2 and 3 dimensions**

**Author:** Jean de Villiers<sup>1</sup>

**Co-author:** Moritz Braun<sup>1</sup>

<sup>1</sup> *University of South Africa*

The problem of fitting material properties on earth to certain models by analysing returned seismic signals are investigated here. Analysis proceeds with inverse methods. Seismic wave inversion is tackled by minimisation of objective function with respect to model parameters. Absorbing boundary conditions are implemented using an exponentially decaying ansatz.

145

## **Modeling of the Corona Ionization space propulsion system**

**Author:** Marius Tchonang Pokaha<sup>1</sup>

**Co-author:** Phil Ferrer<sup>2</sup>

<sup>1</sup> *student*

<sup>2</sup> *Lecturer*

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The Corona Ionization (CorIon) Space Propulsion system is a novel electrostatic thruster, which combines the ionization and acceleration steps of conventional technology. The CorIon's small size and simplicity are advantageous in many situations, such as for satellite station keeping and deep space probes. Experimental results are presented and compared to the theoretical model

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## **Different light sources in photodynamic therapy for use in photorejuvenation**

**Author:** Victoria Van Kets<sup>1</sup>

**Co-authors:** Aletta Karsten<sup>2</sup>; Lester Davids<sup>1</sup>

<sup>1</sup> *University of Cape Town*

<sup>2</sup> *CSIR*



**Corresponding Author:** victoriavankets1@gmail.com

Photodynamic therapy (PDT) has recently emerged as a treatment modality for photorejuvenation of the skin. This study is a preliminary investigation into the effect of different light sources to activate hypericin, a plant-derived photosensitizer in primary human dermal fibroblast cells.

147

## Probing Dark Energy via Age Dating of Luminous Red Galaxies

**Author:** Bishop Mongwane<sup>1</sup>

<sup>1</sup> *Department of astronomy, ACGC, university of Capetown*

**Corresponding Author:** astrobish@gmail.com

The history of entire galaxies is encoded in their spectra. Thus, from spectra, one can answer questions pertaining to evolutionary histories of galaxies. Moreover, the Hubble constant can be constrained through spectroscopic ages of red galaxies. In this work, we analyze how reliably one can age date galaxies, by including the metallicity and star formation history.

148

## Dark Matter signals with the MeerKAT telescope

**Author:** Gopolang Mohlabeng<sup>1</sup>

**Co-author:** Marco Regis<sup>2</sup>

<sup>1</sup> *Student*

<sup>2</sup> *Post Doctoral Candidate*

**Corresponding Author:** mohlabeng319@yahoo.com

The identification of dark matter (DM) is one of the most challenging issues of physics today. A theoretical class of candidates involves weakly interacting massive particles (WIMPs) as DM. DM produces sizable fluxes of relativistic electrons and positrons. Observational prospects for the MeerKAT telescope concerning the emission in a few nearby clusters of galaxies are presented.

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## Molecular Motors on Strands

**Author:** Karl Möller<sup>1</sup>

**Co-author:** Kristian Müller-Nedebock<sup>1</sup>

<sup>1</sup> *Department of Physics, Stellenbosch University*

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Biological filaments can be linked by active crosslinks. Investigating the dynamical behaviour of a system consisting of a large number of filaments and motors would lead to understanding of dynamical mechanical properties and processes in cells. A single motor crosslinked strand is investigated using a functional integral approach.

150

## Chi-square, Maximum Likelihood and Bayes: a simple example

**Author:** Michiel De kock<sup>1</sup>

<sup>1</sup> *University of Stellenbosch*

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Given a histogram of measurements, we compare the chi-squared goodness-of-fit test and the Kullback-Leibler divergence of different models. We then apply these methods for parameter estimation and relate them to the principle of Maximum Likelihood. These non-Bayesian approaches are finally viewed in the light of a Bayesian solution.

151

## Lifetimes and transition probabilities in $^{194}\text{Tl}$

**Author:** Paulus Masiteng<sup>1</sup>

**Co-authors:** A.A Pasternak<sup>2</sup>; D.G. Roux<sup>3</sup>; E.A Lawrie<sup>4</sup>; E.O Lieder<sup>4</sup>; J.F. Sharpey-Shafer<sup>1</sup>; J.J Lawrie<sup>4</sup>; N.V Kheswa<sup>4</sup>; O. Shirinda<sup>1</sup>; P. Papka<sup>4</sup>; R.A Bark<sup>4</sup>; R.M Lieder<sup>4</sup>; S.H.T. Murray<sup>5</sup>; S.M Mullins<sup>4</sup>; S.P Bvumbi<sup>4</sup>; S.S Ntshangase<sup>6</sup>; T.E Madiba<sup>4</sup>

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Lifetimes ( $\tau$ ) of high spin states in  $^{194}\text{Tl}$  have been studied using the DSAM technique with the AFRODITE array. The deduced B(M1) and B(E2) transition probabilities suggest that the two negative parity bands in the  $^{194}\text{Tl}$  are built on the same configuration and correspond to similar nuclear deformation.

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## A Continuum Imaging Survey with MeerKAT

**Author:** Kurt van der Heyden<sup>1</sup>

<sup>1</sup> *UCT*

**Corresponding Author:** heyden@acgc.uct.ac.za

We will undertake a tiered extragalactic continuum survey with MeerKAT to investigate the evolution of AGN, star-forming galaxies and galaxy clusters from the epoch of reionization through to the present day. Our project will fully utilize MeerKAT's unique capabilities, namely high-resolution coupled with a large survey speed, to undertake a five-tier survey strategy at 1.4 GHz. The combination of resolution and sensitivity (outperforming both ASKAP and EVLA) will allow us to make the most precise measurement of the radio luminosity function for radio-loud & radio-quiet AGN and star-forming galaxies over the full range in radio luminosity.

153

## Calibration of an optoelectronic system for the study of solar blind AlGaN-based UV photodiodes

**Author:** Louwrens van Schalkwyk<sup>1</sup>

**Co-authors:** F.D. Auret<sup>2</sup>; W.E. Meyer<sup>3</sup>

<sup>1</sup> *Student*

<sup>2</sup> *Professor of Physics*

<sup>3</sup> *Senior lecturer*

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A calibrated optoelectronic system is required for the study of tuneable intrinsically solar blind AlGaN-based ultraviolet (UV) light sensitive photodiodes. The method of calibration is discussed; where by the spectral irradiance of the UV light incident on the photodiodes are calibrated for wavelengths ranging from 200 nm to 400 nm.

154

## Study of fusion evaporation channels in the $18\text{O} + 18\text{O}$ $E_{\text{lab}} = 65$ MeV reaction

**Author:** ESRA Khaleel<sup>1</sup>

**Co-author:** Paul Papka<sup>2</sup>

<sup>1</sup> *Stellenbosch University*

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The AFRODITE and DIAMANT detectors were used to measure the evaporation channels in the  $18\text{O}+18\text{O}$  reaction. Emission of (p, d, t) and alpha particles were identified with excellent particle identification. The cross sections for evaporation residues production are calculated with the statistical model code CASCADE.

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## Study of fusion evaporation channels in the $18\text{O} + 18\text{O}$ $E_{\text{lab}} = 65$ MeV reaction

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## Detection of forbidden singlet-triplet transitions of $^{12}\text{C}^{16}\text{O}$

**Authors:** Christine Steenkamp<sup>1</sup>; Gareth Dickenson<sup>2</sup>

**Co-authors:** Anton Du Plessis<sup>3</sup>; Anton Nortje<sup>1</sup>; Erich Rohwer<sup>1</sup>

<sup>1</sup> Laser Research Institute, University of Stellenbosch

<sup>2</sup> Laser Centre Vrije Universiteit, Amsterdam, The Netherlands

<sup>3</sup> CSIR National Laser Centre, Pretoria

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Twenty rovibronic transitions of the  $e(v'=5)-X(v''=0)$  band of  $^{12}\text{C}^{16}\text{O}$  for which experimental wavelengths were previously unavailable were recently detected by vacuum ultraviolet laser induced fluorescence excitation spectroscopy. The data is important in astrophysical applications and for comparison to the latest model of  $^{12}\text{C}^{16}\text{O}$ . The experimental techniques that facilitated these measurements will be highlighted.

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## VLBI amplitude calibration for circular polarisation measurement

**Author:** Laura Richter<sup>1</sup>

**Co-authors:** Athol Kembell<sup>2</sup>; Justin Jonas<sup>1</sup>

<sup>1</sup> Rhodes University

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The two main opposing SiO maser polarisation theories can be tested by comparing the circular polarisation of the  $v=1 J=1-0$  and  $v=1 J=2-1$  SiO maser lines. This requires accurate measurements of the circular polarisation. The spectral line VLBI amplitude calibration method is investigated in light of this requirement.

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## Investigation of the photovoltaic performance of dye-sensitised solar cells employing TiO<sub>2</sub> nanotubes

**Author:** Fransciuous Cummings<sup>1</sup>

**Co-authors:** Dirk Knoesen<sup>2</sup>; Lukas Le Roux<sup>1</sup>; Nomthandazo Mutangwa<sup>1</sup>

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<sup>2</sup> *Department of Physics, University of the Western Cape, Private Bag X17, Bellville 7530, South Africa*

**Corresponding Author:** fcummings@csir.co.za

This work compares the performance of dye-sensitised solar cells (DSCs) employing films of highly-ordered TiO<sub>2</sub> nanotubes to traditional DSCs using films of tightly interconnected TiO<sub>2</sub> nanoparticles as the electron transport medium. Moreover, the work investigates whether nanotubes enhance the charge transport phenomena in the cell, thereby producing more efficient DSCs.

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## The variability of the peak height of the ionospheric F2 layer over South Africa

**Author:** Makhangela Mbambo<sup>1</sup>

<sup>1</sup> *University of Fort Hare and Hermanus Magnetic Observatory*

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This paper presents the investigation into the variability of the maximum height of the ionospheric F2 layer (hmF2) over the South African region. The dependence of hmF2 on solar and magnetic activity is also investigated. An initial result shows larger hmF2 variability around midnight than during the day for all seasons.

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## Extracting gravity waves parameters during the September 2002 southern hemisphere stratospheric major warming using a SANAE imaging riometer.

**Author:** Nkanyiso Mbatha<sup>1</sup>

<sup>1</sup> *UKZN and HMO*

**Corresponding Author:** nmbatha@hmo.ac.za

Using absorption data measured by imaging riometer for ionospheric studies (IRIS) located at the South Africa National Antarctic Expedition (SANAE), Antarctica (72°S, 3°W), we extracted the parameters of gravity waves (GW) of periods between 35 and 55 minutes during the period from 16 to 30 September 2002, a period of major sudden stratospheric warming (SSW) in the Southern Hemispheric middle atmosphere.

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## Characterization of the Ionosphere over the South Atlantic Anomaly by using a ship based Dual Frequency GPS receiver

**Author:** SJ Van der Merwe<sup>1</sup>

**Co-authors:** Pierre Cilliers<sup>2</sup>; Pieter De Villiers<sup>3</sup>

<sup>1</sup> *University of Pretoria/Hermanus Magnetic Observatory*

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<sup>3</sup> *University of Pretoria*

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This paper briefly describes a novel approach to characterizing the ionosphere over the South Atlantic Geomagnetic Anomaly using a ship-based dual frequency GPS receiver. Applications include but are not limited to HF propagation path prediction for communication and GPS positioning applications, specifically operating in this zone of abnormal magnetic activity.

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## The design and construction of an intracavity SLM laser

**Author:** Liesl Burger<sup>1</sup>

**Co-authors:** Andrew Forbes<sup>1</sup>; Igor Litvin<sup>1</sup>

<sup>1</sup> *National Laser Centre*

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We describe design considerations and the steps taken to build a laser resonator with an intracavity spatial light modulator. We then discuss the performance of this laser, with observations and problems specific to this configuration.

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## EFFECTS OF Mo DOPING ON THE SPIN-DENSITY-WAVE BEHAVIOUR OF A Cr + 2.5 at.% Si alloy

**Author:** Charles Sheppard<sup>1</sup>

**Co-authors:** Aletta Prinsloo<sup>1</sup>; Andre Strydom<sup>1</sup>; Herman Alberts<sup>1</sup>

<sup>1</sup> *Department of Physics, University of Johannesburg*

**Corresponding Author:** cjsheppard@uj.ac.za

The influence of Mo-doping on the first-order Néel transition of a Cr<sub>0.975</sub>Si<sub>0.025</sub> alloy is investigated through electrical resistivity, specific heat and thermal transport measurements. The results suggest the absence of antiferromagnetism in (Cr<sub>97.5</sub>Si<sub>2.5</sub>)<sub>1-y</sub>Moy alloys with  $y \geq 0.025$ .

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## Vacuum ultraviolet laser spectroscopy of four carbon monoxide isotopomers

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A tunable, narrow bandwidth vacuum ultraviolet laser source was applied to fluorescence excitation spectroscopy of four carbon monoxide isotopomers. The high spectral resolution and sensitivity of the technique facilitated detection of the lines of rare isotopomers and forbidden transitions. In this poster we give an overview of results and recent progress.

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## **Pade approximation of the S-matrix as a way of locating quantum resonances and bound states: two-channel case**

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We extend the method for locating spectral points generated by central potentials to the multichannel case. The key to the method is the combination of analytic properties of the Jost matrices and rational parametrization of the S-matrix obtained at real collision energies. An explicit derivation of some symmetry properties of the Jost matrices is given. Numerical examples demonstrate the stability and accuracy of the proposed method.

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## **Measuring neutron fluence at the fast neutron facility at iThemba LABS**

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A new neutron beam monitoring system was installed at iThemba LABS. The instruments included a parallel plate U238 fission ionization chamber, a gain stabilized NE213 detector which is a high resolution instrument for measuring the spectral distribution of the beam using the time-of-flight method and an NE102 transmission detector. A measurement campaign was successfully performed over three runs at iThemba LABS in August 2009 at 66 MeV, 100 MeV and 200 MeV proton beam energies and the data collected will be used to obtain measurements of the relative fluence and the spectral fluence of the neutron beam.

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## Statistics of continuous weak quantum measurement.

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The theory of continuous weak measurement provides a tool to monitor the evolution of the wavefunction of a single quantum system in real time. We study the statistics of continuous monitoring of the position of a particle subject to several potentials.

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## Identification of Threshold Temperature For The Generation of Defects Associated with Superionic Region in BaF<sub>2</sub> Using Positron Annihilation Technique

**Author:** Thulani Jili<sup>1</sup>

**Co-authors:** Betty Kibirige<sup>1</sup>; Elias Sideras-Haddad<sup>2</sup>; Thembinkosi Nyawo<sup>1</sup>

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There is an uncertainty surrounding the generation of defects associated with superionic conductivity in terms of whether these are created at an observed transitional temperature  $T_c$ , or at an earlier temperature point. The measured conductivity becomes more pronounced at a temperature coinciding with the deviation of constant lattice parameter from 6.2096 angstrom. The Frenkel pairs responsible for superionic region are generated well below the actual transitional temperature and this is informed by the calculation of S-parameter and positron lifetime.

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## Evolution of Magnetic Phase Transition in C<sub>x</sub>La(1-x)Ru<sub>2</sub>Al<sub>10</sub> compounds

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**Co-author:** Andre M Strydom<sup>1</sup>

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The magnetic susceptibility and specific heat data are reported for the substitutional compounds C<sub>x</sub>La(1-x)Ru<sub>2</sub>Al<sub>10</sub> ( $x = 0.99$ – $0.4$ ). With decreasing  $x$ , i.e., increasing La doping, the antiferromagnetic-like transition,  $T_0$ , shifts down systematically to lower temperatures.



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## An Equilibrium Perspective on the Mechanical Properties of Active networks

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**Co-authors:** Kristian K. Müller-Nedebock <sup>2</sup>; Leandro Boonzaaier <sup>2</sup>

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The understanding of mechanical properties of active polymer networks can provide insights on the functioning of a range of biological materials. In this paper we first present a simple model for a network of two flexible polymer filaments connected by a molecular motor cluster and the network ideas are further extend to a multi stranded network. We learn that active network components lead to internal stresses which ultimately lead to network contraction.

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## Thermodynamic stability of VO<sub>2</sub> in contact with thin metal films

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**Co-authors:** Betty Kibirige <sup>1</sup>; Ouassini Nemraoui <sup>1</sup>; Percy Sefage <sup>1</sup>; Thembinkosi Nyawo <sup>1</sup>

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Solid state compound phase formation has been investigated between thin metal films (Co, Hf, Ni, Pd and Pt) and VO<sub>2</sub> substrates using RBS and XRD. The thin-film couples were annealed from 45 min to 1 hr between 400 and 900 degrees centigrade. It was found that Hf reacts with VO<sub>2</sub> whereas Co, Ni, Pd and Pt do not. Heats of reaction were calculated for all possible combinations of the vanadium alloy and metal oxide reaction products. Comparison with experimental results show in all cases that reactions take place for negative heats of reaction. Results obtained correlete well with a Miedema parameter providing a way of predicting a reaction.

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## CONTROL OF MOLECULAR SINGLET-TRIPLET STATE CHARACTER USING AUTLER-TOWNES EFFECT

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**Co-authors:** A. Marjatta Lyyra <sup>2</sup>; Ergin H. Ahmed <sup>2</sup>; John Huennekens <sup>3</sup>; Omer Salihoglu <sup>2</sup>; Sonja Ingram <sup>2</sup>; Yafei Guan <sup>2</sup>

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We present the use of Autler-Townes effect to control the singlet-triplet state character in molecules. In a three-laser excitation scheme in lithium dimer we demonstrate that application of a strong enough coupling field to the singlet component of a singlet-triplet mixed pair leads to significant enhancement in the mixing coefficients and therefore the amount of singlet or triplet character in the pair of states which are initially mixed by the spin-orbit interaction. Our theoretical model based on solving the density matrix equations of motion gives preliminary simulations which are in good agreement with the experimental data even though

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## **A Platform for Photon Simulation Using Modern Low Cost Many-Core Processing Architectures**

**Author:** Bernardt Duvenhage<sup>1</sup>

**Co-author:** Derek Griffith <sup>1</sup>

<sup>1</sup> *Optronic Sensor Systems, Defence Peace Safety and Security, CSIR*

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The main research focus is on developing photon simulation algorithms for modern low cost many-core processor architectures. These algorithms all articulate models which offer efficient simulation of the mechanics of photon-material interactions and radiance transport. This paper focusses on the processor architecture for potentially a more general computational application.

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## **Matching Stellar envelopes to ATLAS9 atmospheres.**

**Author:** Zolile Mguda<sup>1</sup>

<sup>1</sup> *Dept of Astronomy, Astrophysics, Cosmology and Gravity Center University of Cape Town*

A comparison of some equilibrium stellar models with stellar pulsation observations is presented. We compare atmosphere models with observations and pulsation models with observed pulsation modes asteroseismology observations

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## **The Shapes of THINGS HI Profile**

**Author:** Roger IANJAMASIMANANA<sup>1</sup>

**Co-author:** Erwin W. J. G de Blok <sup>1</sup>

<sup>1</sup> *Astronomy Department, Astrophysics, Cosmology and Gravity Centre (ACGC), University of Cape Town, Private Bag X3, Rondebosch 7701, South Africa*

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We present a novel method to study the relationship between gas content of galaxies, their star formation activity and the phase structure of the ISM. We do this by summing all individual profiles in the data cubes of the THINGS samples.

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## **An algorithm for calculating current transport along a carbon monolayer - superconductor interface**

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<sup>1</sup> *Stellenbosch University*

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A recursive Green's function algorithm is used to calculate the current transport along the interface of a graphene sheet and a superconductor. The difficulty of hole and particle excitations coupling near the interface is resolved by mapping the Hamiltonian onto another equivalent Hamiltonian that can be represented in the algorithm.

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## **Structural studies of metal-doped titania systems using XRD and SEM**

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**Co-authors:** T Hillie<sup>2</sup>; TE Mosuang<sup>3</sup>

<sup>1</sup> *University of Limpopo*

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Au and Pd doped TiO<sub>2</sub> nanocrystals were prepared using sol-gel routes. Scanning Electron Microscopy(SEM) and X-ray diffraction(XRD) techniques were used to characterize the samples. The effects of dopants on the phase transformation and grain growth were investigated. Gold does not affect the anatase-rutile transformation temperature whereas palladium does.

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## **Effects of a secondary concentrator and heat mirror on a solar trough receiver**

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We consider ways of increasing efficiency of solar trough receiver pipes by decreasing the leading thermal radiation losses. We study the use of a secondary concentrator, a “solar funnel”, which reduces the area that emits thermal radiation. We further increase efficiency by use of a heat mirror on the glass cover which reflects the thermal radiation being emitted by the receiver pipe back onto itself.

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## Deep NIR Surface Photometry of HI Galaxies behind the Galactic Plane

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I present results from a deep near-infrared survey of gas-rich galaxies behind the plane of our Galaxy. Accurate surface photometry, with careful attention to star-subtraction, has been performed and total magnitudes have been determined for the sample. This data, combined with existing 21-cm spectra, is used to calculate Tully-Fisher distances.

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## Direct projectile break-up of $^{12}\text{C}$ at 33.3 MeV/nucleon.

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**Co-authors:** A. A Cowley <sup>2</sup>; E. Z Buthelezi <sup>2</sup>; F. D Smit <sup>2</sup>; G. F Steyn <sup>2</sup>; I. T Usman <sup>2</sup>; J Mabila <sup>3</sup>; P Papka <sup>3</sup>; R Neveling <sup>2</sup>; S. H Connell <sup>4</sup>; S. V Fortsch <sup>2</sup>

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The binary breakup of  $^{12}\text{C}$  into  $^8\text{Be}$  fragments and alpha particles were measured in coincidence in the interaction of 33.3 MeV/nucleon  $^{12}\text{C}$  projectiles with  $^{197}\text{Au}$ ,  $^{93}\text{Nb}$  and  $^{12}\text{C}$  target nuclei. Preliminary experimental cross-section contributions are extracted for both quasi-elastic and the inelastic break-up processes.

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## The effect of Hagedorn model in the nuclear matter on thermodynamic quantities

**Author:** Dawit Worku<sup>1</sup>

**Co-authors:** Azwinndini Muronga <sup>1</sup>; Jean Cleymans <sup>1</sup>

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We analyze recent data on particle production yields which is obtained in collider experiments within the statistical model. We calculate the thermodynamic quantities and speed of sound in a resonance hadron gases, whose mass spectrum is assumed to have hagedorn form. Finally, we compared our results with those obtained from other models.

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## **Modern computer based experiments versus “Traditional” experiments: The experience of first year physics students.**

**Author:** Jacques Bezuidenhout<sup>1</sup>

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The Faculty of Military Science of Stellenbosch University presents Algebra-based Physics courses to military cadets. The practical component comprises experiments that utilise classical apparatus, as well as more modern computer based experiments. Questionnaires are yearly completed by the students to evaluate the theoretical and practical components of the course. This paper will explore some of the results of these surveys, focusing especially on the experience of the student with regards to the types of experiments that are presented.

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## **Identification of potential lithium-rich stars in the Large Magellanic Cloud for observation with SALT**

**Author:** Christoph Hagspiel<sup>1</sup>

<sup>1</sup> *University of Cape Town*

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Combining information from the OGLE-III and 2MASS surveys, we have identified large amplitude, Mira, variables that lie above the well defined period-luminosity relation. It has been suggested that such stars may get additional luminosity from envelope burning and we propose to investigate this by looking for lithium with SALT.

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## **Ab initio investigation of Si-C alloys**

**Author:** Richard Andrew<sup>1</sup>

<sup>1</sup> *University of Pretoria*

Silicon and Carbon exist readily in pure form and in the 50/50 combination of Silicon Carbide in cubic and hexagonal forms. Carbon is known to be slightly soluble in Si and vice-versa and the

reasons for this are not well known. To investigate this, the stability of various Six-1Cx alloys were investigated with x ranging between 0 and 1.

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## The covariant approach to f(R) theories of gravity

**Author:** Anne Marie Nzioki<sup>1</sup>

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Modifications to General Relativity have been proposed to accommodate recent observations and for the most part, the focus has been on the f(R) theories of gravity. We review the features of f(R) theories of gravity by presenting their theoretical and observational aspects using the covariant approach.

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## An authentic depiction and classification of elemental electric and magnetic dipole moments

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A sequel to representing elemental sources of magnetic fields as elemental magnetic vector charges is realizing that electric and magnetic dipole moments are different classes of first order moments, each being a pair of allied monopolar moments. This shifts acutely from traditional notions like Dirac's magnetic (scalar) charge.

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## Pulse-Laser-Synthesis of FexSiO1-xClx Nanostructures and Their Properties

**Author:** Steven Nkosi<sup>1</sup>

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Several types of Fe-Si mixed oxide composites have been synthesized for biomedical, switching and applications [1, 2]. The synthesis, properties, and environmental applications of nanoscale Iron-based material comparing them with non-nanoscale have already been discussed [3]. In order to enhance the material properties and performance the method of synthesis could have an influence hence the methods of preparation are determining factors in producing different sizes and shapes.

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## Raman spectra of hot-pressed B6O: Some new results

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**Co-authors:** B.W. Mwakikunga<sup>2</sup>; E. Manikandan<sup>3</sup>; I Sigalas<sup>1</sup>; T.E. Derry<sup>4</sup>

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By means of the application of an efficient fluorescence background suppression scheme, the first-, second-, and higher- order Raman spectra of B6O was obtained, which till now had been deemed un-observable when the 514.5 nm excitation line is used. We report on the analysis, of the the first-order and second-order Raman spectra and compare these to the Raman spectra or other boron-rich ultra-hard materials.

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## Analysis of the nanoindentation load–depth curves measured on fluorine irradiated B6O ceramics

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**Co-authors:** I Sigalas<sup>1</sup>; J Neethling<sup>2</sup>; T.E. Derry<sup>3</sup>

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Using the nanoindentation technique and the Oliver & Pharr analysis method of the measured loading and unloading segments of the load-displacement curves, the hardness and Young's modulus were determined for unirradiated and implanted B6O. The implanted hot-pressed B6O was irradiated with 150 keV fluorine in the dose range of  $5 \times 10^{14}$  to  $5 \times 10^{16}$  ions/cm<sup>2</sup> at room temperature. The implanted samples showed a decrease in hardness compared to the unimplanted material.

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## Establishment of the Exact Quantum Numbers of Critical Rotational Bands in Gd-155

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Excited states in  $^{155}\text{Gd}$  nuclei were populated in the  $^{154}\text{Sm}(\alpha, 3n)$  reaction at a beam energy of 33MeV. The aim is to establish firm spin and parity assignments for the many complex rotational bands that have been observed in this nucleus and to observe which couplings are blocked by which quasi-neutrons in order to establish the underlying microstructure of the collective excitations of the  $^{154}\text{Gd}$  core.

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## **Ab-initio Study of the Properties of Advanced Metal Nitrides $\text{M}_2\text{N}_3$ (where $\text{M} = \text{Ta}, \text{V}, \text{Nb}$ )**

**Author:** Esther Orisakwe<sup>1</sup>

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The structural, elastic, and electronic properties of the advanced metal nitrides  $\text{M}_2\text{N}_3$  and their ternary phases are investigated using ab-initio plane wave pseudopotentials under the framework of density functional theory. The relative stability of the ternary phases were also computed. Results obtained were compared with the available experimental and theoretical data.

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## **Experimental investigation of Q-switched Erbium-Doped Fiber Laser**

**Authors:** Jean Jacques Kaboko<sup>1</sup>; Johan Meyer<sup>2</sup>; Rodolfo Martinez<sup>1</sup>

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In this project, a design and experimental investigation of a Q-switched fiber lasers are presented. Using the Q switched technique, the peak power and time duration of the laser pulses are analyzed as function of repetition rate, pumping power, cavity length and output coupler transmission.

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## **Possible chirality in $^{195}\text{Tl}$ , associated with a three quasiparticle configuration.**

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<sup>1</sup> *iThemba LABS - UCT*



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The level scheme of  $^{195}\text{Tl}$  was studied and a few new transitions, belonging to a possible chiral partner band, were found. The measured  $B(M1)/B(E2)$  ratios for the partner bands show similarities, in accordance with possible chiral nature. A measurement of the gamma ray intensities is in progress.

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## Frequency Modulation Continuous Wave (FMCW) technique applied to Optical Fiber Temperature Sensors

**Authors:** Johan Meyer<sup>1</sup>; Nadine Shuda<sup>1</sup>; Rodolfo Martinez<sup>1</sup>

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The application of the FMCW technique to an optical fiber temperature sensor is investigated and tested experimentally in this project. Multiplexing of the sensor and variation of the sensitivity when parameters are varied is also investigated and simulated.

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## Open Loop Interferometric Fiber Optic Gyroscope

**Authors:** Johan Meyer<sup>1</sup>; Rodolfo Martinez<sup>1</sup>; Yogan Naidoo<sup>1</sup>

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The operation of a fiber optic gyroscope is demonstrated in this project. A fiber optic gyroscope is designed, constructed and tested and the response of the gyroscope to an input rotation is generated. The experimental setup as well as the results are discussed in this paper.

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## Non-ideal fluid dynamics in (2+1) dimensions planar geometry

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The flux corrected transport algorithm FCTHydro provides tools for solving continuity equations. We study the dynamical evolution of non-ideal fluid dynamics in the non-relativistic limit using the (2+1)D planar geometry. The system studied shall be generalised to simulate relativistic hydrodynamic systems, which are of interest in heavy ion collisions.

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## Investigating the Teaching and Learning of Problem Solving in Physics at School and University Level

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In this study we report that while test scores continue to indicate that students' creative problem solving ability lags their ability to perform routine exercises, preliminary data suggest that instructors at both high school level and at university level are perhaps simply not teaching their students creative problem solving.

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## Tropospheric and Stratospheric Temperature Measurements by Vibrational Raman-N<sub>2</sub> LiDAR at Reunion Island (20.8°S, 55.5°E)

**Author:** Hassan BENCHERIF<sup>1</sup>

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The improvement of the laser sources allows LiDAR to probe an increasing altitude range of the atmosphere with improved vertical and time resolutions. Several methods using LiDAR technique have been developed to retrieve temperature in the UTLS. However, the Rayleigh technique is limited and can not operate below the 30km height, while the vibrational Raman-N<sub>2</sub> technique has been developed in order to measure temperature profiles in the UTLS region.

In this study, we present the Raman-N<sub>2</sub> LiDAR operating at Reunion Island; the temperature retrieval method; and the main results about the thermal structures in the UTLS as derived from a 10-year

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## A new Method for Solving the Three-Dimensional Schroedinger Equation in the Presence of Coulomb Singularities

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Solving an effective three-dimensional Schroedinger equation is a key ingredient of computational methods for the calculation of atomic, molecular and solid state properties. However, the presence of Coulomb singularities at the nuclei is a challenge for the convergence of any method. In this contribution a new approach is introduced, which is based on writing the wave function as a product of a function that fulfills the cusp condition at all nuclei and a second function that is expanded in

a finite element basis set. This approach is discussed in some detail yielding a variational principle for the second function.

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## STATUS OF THE ION SOURCES AT iTHEMBA LABS

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Heavy ion beams at iThemba LABS have been produced in a 10GHz Minimafof Electron Cyclotron Resonance (ECRIS) for the past two decades. The increase in demand for new ion species and high intensity beams from the nuclear physics community has led to a decision to procure a new 2nd generation ECRIS. The source is a room temperature ECRIS based on the Grenoble Test Source (GTS) design. The source has been assembled and is being commissioned at iThemba LABS. The Hahn-Meitner-Institute (HMI) in Berlin donated their 14.5GHz ECRIS to iThemba LABS where it is presently operational. iThemba LABS also produce polarized proton beams.

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## Fe/S sample preparation: A method for the calculation of the S concentration required for doping Fe crystals

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A method is proposed for the preparation of Fe/S samples using molecular Sulfur to dope Iron samples at high temperatures. Using Fick's semi-infinite diffusion model the time needed to obtain a certain bulk concentration at a specified temperature is calculated. Experimental results obtained this far confirms the possibility of such an experiment.

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## FOUR – YEAR PROGAM STUDENTS PHYSICS DIFFICULTIES

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2010 SAIP ABSTRACT

D Dale, N C Moji, Q Motsoeneng, T Hlatshwayo and W Mtangi.

An Investigation of the abilities of students, to infer from an experiment done on the cooling down of hot water to room temperature that the Temperature – time graph of cold water heating up to room temperature will be the opposite. Most students could not accomplish this in a class test.

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## High-power diode-end-pumped Tm:YLF slab laser delivering 189 W at 1890 nm

**Author:** Wayne Koen<sup>1</sup>

**Co-authors:** Christoph Bollig<sup>1</sup>; Daniel Esser<sup>1</sup>; Hencharl Strauss<sup>1</sup>

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We present a high-power Tm:YLF slab laser double-end-pumped by two 300 W laser diode stacks. The resonator was designed such that the laser emitted at 1890 nm instead of the conventional operating wavelength of 1912 nm. At full incident pump power it delivered up to 189 W of stable output.

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## Are BSc Extended Programmes necessary in South Africa?

**Author:** Deena Naidoo<sup>1</sup>

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A comparison of the BSc extended and mainstream programmes in Physics at the University of the Witwatersrand are reviewed in order to facilitate possible processes to assist the new cohort of Outcome Based Education learners who generally lack the necessary mathematical and conceptual skills required for university.

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## Analysis of IV and CV characteristics of Au/Ni/n-AlGaIn Schottky contacts at different temperatures

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**Co-authors:** Danie Auret<sup>1</sup>; Matshisa Legodi<sup>1</sup>; Mmantsae Diale<sup>1</sup>; Walter Meyer<sup>1</sup>

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We report the current-voltage-temperature characteristics of Au/Ni/n-Al<sub>0.35</sub>Ga<sub>0.65</sub>In Schottky contacts measured over a wide temperature range. For larger forward bias, the current-voltage characteristics were well described by the thermionic emission model. By means of curve fitting, we could determine the relative contribution of the conduction mechanisms at each temperature.

208

## Octupole Excitations in U isotopes

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The actinide region attracts considerable interest due to the rich variety of octupole phenomena encountered both theoretically and experimentally[1]. These include octupole vibrational bands which, as a function of neutron number and angular momentum, develop into alternating parity bands that have been interpreted as the onset of octupole deformation, or more recently, in terms of reflection-asymmetric tidal waves[2]. The most spectacular example of octupole shape may well be the hyperdeformed bands known from fission resonances.

209

## Ab initio study of the crystal structures and mechanical properties of some late transition-metal nitrides

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The crystal structures and mechanical properties of some late transition metal-nitrides at different stoichiometries and different structures have been investigated using first-principles density-functional theory. Obtained results were compared with theory and with experiment whenever possible.

210

## Experimental phantom verification studies for simulations of light interactions with skin

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**Co-authors:** Ann Singh<sup>1</sup>; Shaimaa Abd Almonem<sup>2</sup>

<sup>1</sup> *CSIR, National Laser Centre*

<sup>2</sup> *Niles intitute, Cairo University*

Raytracing computer models are valuable tools to determine the fluence at a specific depth into tissue, but need to be verified before they can be used with confidence. Such a model for skin showed good agreement (within 10%) when compared with images from experiments on solid resin skin simulation phantoms.

211

## Micro Machining of Fabry-Perot Interferometers in Optical Fbers to Manufacture Temperature Sensors

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Abstract: We have designed an experimental setup to micro machine Fabry-Perot interferometer in silica and sapphire fiber with a Ti:sapphire femtosecond laser and in comparison with a nanosecond Nd:YAG laser at 355 nm. We achieved spot sizes of 5  $\mu\text{m}$  with the Ti:sapphire and 20  $\mu\text{m}$  with the Nd:YAG laser.

212

## **Structural Phase Transitions and Pressure Dependent Electronic Structure of ZnO**

**Author:** Mahlaga Molepo<sup>1</sup>

**Co-author:** Daniel Joubert<sup>1</sup>

<sup>1</sup> *University of the Witwatersrand*

Groundstate and hybrid density functional calculations are used to examine the structural and electronic properties of ZnO under high pressure. The generalized gradient approximation is employed to examine the ground state structural properties while the B3LYP hybrid functional is used for the electronic properties. In agreement with previous studies, it is found that ZnO transforms from the wurtzite structure to the CsCl structure, with the rocksalt structure as the intermediate phase. Emphasis is laid on the behavior of the band-gap with increasing pressure.

214

## **PREDICTION AND VERIFICATION OF A HIGH POWER EXPERIMENTAL ROCKET**

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<sup>1</sup> *cj*

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Over the past five decades a number of South African institutions have developed capabilities and facilities in various fields of space science and technology. This paper describes an experimental rocket launch project in line with the ongoing South African Space programme.

215

## **In-situ, real-time RBS study of thin film growth in Pd and Ge**

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**Co-author:** Craig Comrie<sup>1</sup>

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Palladium germanide formation is studied in ramped anneals of constant ramp rate using real-time RBS. The resulting data is analysed using both Kissinger analysis and fitting an integral to a single ramped anneal. The activation energies determined by both methods are in good agreement.

216

## Prolonging coherence in trapped ions

**Author:** Hermann Uys<sup>1</sup>

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We study pulse sequences that dynamically decouple  $^9\text{Be}^+$  ions from their decohering environment. The noise environment the ions see is artificially synthesized to emulate a variety of physical systems. By incorporating measurement feedback, our locally optimized dynamical decoupling sequences (LODD) attain an order of magnitude improved suppression of noise in certain noise environments compared to known sequences.

217

## First principles studies of electronic and structural properties of defects in boronitrene

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We study the impact of C substitutional atoms, B and N atom swapping and vacancies, and some adatoms on electronic and structural properties of boronitrene (2D boron nitride) using the VASP code. The generalized gradient approximation is the initially used exchange correlation functional. Our results show good agreement with literature.

218

## Data Reduction Pipeline for Optical Photometry Data

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**Co-authors:** Abraham van der Linde<sup>1</sup>; Pieter Meintjes<sup>1</sup>

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A pipeline for reducing optical photometry data is presented. It is set in the IRAF environment and coded using CL scripting. The main focus of the project is to ease and speed-up the reduction of differential photometry data, with aperture- and psf fitting both supported.

219

## Probing of diffuse radio emission in the Abell 1437 Supercluster

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An important aspect of the radio emission from clusters of galaxy is represented as the diffuse radio sources associated with the intracluster medium. These radio sources are known as radio halos, relics and mini halos. The radio halos and relics are indicators of cluster mergers. We are probing the same into the submerger A1437 supercluster.

220

## Scaling ion traps for quantum computing

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**Co-authors:** A.P. VanDevender<sup>2</sup>; C Ospelkaus<sup>2</sup>; D Leibfried<sup>2</sup>; D.J. Wineland<sup>2</sup>; J Britton<sup>2</sup>; J.H. Wesenberg<sup>3</sup>; J.J. Bollinger<sup>2</sup>; J.M. Amini<sup>4</sup>; S Seidelin<sup>5</sup>

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The design, fabrication and preliminary testing of a chipscale, multi-zone, surface electrode ion trap is reported. The modular design and fabrication techniques used are anticipated to advance scalability of ion trap quantum computing architectures.

221

## Decoherence of superposition states in trapped ions

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We investigate the decoherence of superpositions of hyperfine states of  $^9\text{Be}^+$  ions due to spontaneous scattering of off-resonant light. We find that, contrary to conventional wisdom, elastic Rayleigh scattering can have major contributions to decoherence when compared to the effect of inelastic Raman scattering.

222

## Deposition of thin Cr<sub>3</sub>C<sub>2</sub> hard coatings using Radio Frequency Magnetron Sputtering for SBS characterization

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Cr<sub>3</sub>C<sub>2</sub> films on Si have been grown by RF sputtering at 0 and -60V bias to observe stress relaxation using surface Brillouin scattering. A RF power of 175W and Ar<sub>2</sub> working gas pressure of 5.0 x10<sup>-3</sup>mBar was used to yield a deposition rate of 0.16nm/s. Surface Brillouin studies on the -60V biased and the unbiased samples show high frequency Sezawa modes indicative of high film quality. The dispersion curves have shown an increase in the elastic constants corresponding to an increase in residual stress upon biasing. The elastic constants will be extracted from the dispersion curves.

223

## Detecting yocto( $10^{-24}$ ) newton forces with trapped ions

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We report a calibrated measurement of 174 yoctonewton ( $1 \times 10^{-24}$  *textnormalN* = 1 *textnormalyN*), using a cloud of 60  $^9\text{Be}^+$  ion confined in a Penning ion trap. These measurements suggest that ion traps may form the basis of a new class of ultra-sensitive deployable force sensors.

224

## EFFECT OF THE PLASMA DEPOSITION PARAMETERS ON THE PROPERTIES OF Ti/TiC MULTILAYERS FOR HARD COATINGS APPLICATIONS

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In this study, we present the effect of the plasma deposition parameters on the properties of Ti/TiC multilayers deposited by RF-Magnetron Sputtering (13.56 MHz) under methan and argon reactive plasma at low pressure. The film depositions have been done on silicon and steel substrates. The attention was given to study the influence of different parameters (deposition time, RF power, and total pressure, gas mixture (Ar + CH<sub>4</sub>)) on the film growth rates, thickness and hardness. Films of several thickness and compositions have been deposited and characterised.

225

## Ab initio Calculations of Phonon Spectra in PtCr Binary

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<sup>2</sup> *University of Limpopo*

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We investigate the thermal stability at 0 GPa for different phases of PtCr binary alloys. We have detected soft modes at X, G, M and R points of the Brillouin zone from the phonon spectra of Pt<sub>3</sub>Cr A15 phase. Pt<sub>3</sub>Cr L12 and PtCr<sub>3</sub> A15 are predicted as dynamically stable structures.

226

## XRD Characterisation of SnO<sub>2</sub> doped with both Y and Al

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**Co-authors:** T Hillie<sup>2</sup>; TE Mosuang<sup>1</sup>

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There is a growing interest in nano-materials since they have unique physical and chemical properties. The problem is that they tend to grow at relatively moderate temperatures, with subsequent loss of nano-crystalline behaviour. In this contribution we discuss the effects of incorporating both Y and Al in SnO<sub>2</sub> on crystal growth.

227

## Long-term Optical Properties of High Mass X-ray Binaries in the Small Magellanic Cloud

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**Co-author:** Phil Charles<sup>2</sup>

<sup>1</sup> *South African Astronomical Observatory / University of Cape Town (SAAO/UCT)*

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We present 16 yr baseline optical lightcurves of Be/X-ray binaries (BeX) in the SMC. All the BeX in our sample display both orbital (usually tens of days) modulation, plus a much longer non-orbital variation on timescales of  $\sim 200$ -3000 d. We compare and contrast their behaviour with the prototypical BeX, A0538-66. In addition, the amplitude of their orbital outbursts can vary through the long-term superorbital cycle. We discuss mechanisms which can produce this effect, as well as an apparent correlation between these periodicities.

228

## The changes caused by magnetospheric electric field on high-latitude ionosphere during magnetosphere-ionosphere coupling.

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**Co-authors:** Lindsay Magnus<sup>2</sup>; Sadha Pillay<sup>1</sup>

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On the 09/08/2002 the Cluster spacecrafts footprint where located within the field of view of the Syowa East SuperDARN radar. The variations in the magnetospheric electric field observed by the spacecrafts were compared to the line-of-sight velocity observed by radar. The 3 min delay was observed during magnetosphere-ionosphere coupling.

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## Molecular Dynamics Study of Electrolytic Manganese Dioxide (EMD)

**Author:** Rapela Maphanga<sup>1</sup>

<sup>1</sup> *University of Limpopo*

The EMD is an intergrowth of pyrolusite and ramsdellite-MnO<sub>2</sub> polymorphs. Amorphization and recrystallization technique has been used to generate MnO<sub>2</sub> structures and study their structural properties. The simulation methodology involves allowing an amorphous transition, enabling various structural modifications to evolve during simulation in response to lattice misfit and underlying support.

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## Very long-term behaviour of LMXBs

**Author:** Marissa Kotze<sup>1</sup>

**Co-author:** Phil Charles<sup>2</sup>

<sup>1</sup> *SAAO & UCT*

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Certain Low Mass X-ray Binaries show very long-term quasi-periodic modulations in their X-ray lightcurves, as obtained from the All Sky Monitor on board the Rossi X-ray Timing Explorer. This suggests long-term variations in the mass-transfer rate from the donor, possibly as a result of its solar-like magnetic cycles.

231

## Energetic stability and magnetic ordering properties of 3d transition metals in diamond

**Authors:** E B Lombardi<sup>1</sup>; E M Benecha<sup>2</sup>

<sup>1</sup> *Physics Department, University of South Africa (UNISA)*

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The energetic stability and magnetic ordering properties of 3d transition metals in diamond are investigated using ab initio DFT methods. The divacancy is predicted to be the energetically most favourable site, with Cr, Mn, Fe, Co and Ni having the lowest formation energies. Spin polarised impurity bands are induced in the diamond band gap, suggesting that these elements are likely to order ferromagnetically when incorporated into diamond.

232

## Probing galaxy transformation in Abell 1437

**Author:** J.P. Kotze<sup>1</sup>

**Co-authors:** P. Vaisanen<sup>2</sup>; P.A. Woudt<sup>1</sup>; R. C. Kraan-Korteweg<sup>1</sup>

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Strong observational evidence for the transformation of galaxies in dense environments exists. The processes responsible for this transformation remains an open question. We report on the use of the GALEV evolutionary synthesis models as a means to probe galaxy transformation processes in the galaxy cluster Abell 1437.

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## The nature of the ultraluminous X-ray source NGC 5408 X-1

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We report on the recent observation of a 115-day modulation in the X-ray flux of the ultraluminous X-ray source (ULX) NGC 5408 X-1, and in particular, the interpretation of this modulation as the orbital period. We suggest that this modulation is more likely superorbital in nature. Comparing the properties of this ULX with those of the prototype micro-quasar SS 433, we argue that NGC 5408 X-1 may be very similar to SS 433: a hyper-accreting stellar-mass black hole in a shorter-period binary, and hence the 115-day modulation is due to inner-disc/jet precession.

234

## One-way Quantum Computing with OAM photons

**Author:** Humairah Bassa<sup>1</sup>

**Co-authors:** Andrew Forbes<sup>2</sup>; Francesco Petruccione<sup>1</sup>; Stef Roux<sup>2</sup>; Thomas Konrad<sup>1</sup>

<sup>1</sup> *University of KwaZulu-Natal*

<sup>2</sup> *CSIR National Laser Center*

We study the implementation of the Grover Search Algorithm by means of photons that carry orbital angular momentum (OAM) using the one-way quantum computing (1WQC) model. Our setup is related to a corresponding scheme of Zeilinger et al [1], which realizes a two-bit Grover Search by employing the polarization of photons.

[1] Anton Zeilinger et al. Experimental One-way Quantum Computing, Nature 434, 169-176.

235

## Radiometric analyses of iThemba LABS dam water samples by gamma-ray spectrometry

**Author:** Peane Peter Maleka<sup>1</sup>

**Co-authors:** Israel N. Hlatshwayo<sup>2</sup>; Richard T. Newman<sup>2</sup>

<sup>1</sup> *iThemba LABS and University of the Western Cape*

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The iThemba LABS dam water samples were radiometrically analysed using the low-background high-resolution gamma-ray spectrometry for traces of anthropogenic radionuclides. The samples were prepared in a 1-l Marinelli beaker geometry. Traces of anthropogenic radionuclides have been recorded in samples with activity concentrations ranging from 0.3 to 40 Bq/l.

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## Dipole Bands in Hg-196

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New experimental results from a gamma spectroscopic study of Hg-196 reveal two dipole bands, with even and odd parity respectively. One was previously observed, while the other is new. In both cases spin and parity assignments were possible.

237

## Ultrafast Photochromism of Dithizonatephenyl-mercury(II)

**Author:** Gurthwin Bosman<sup>1</sup>

**Co-authors:** Erich Rohwer<sup>1</sup>; Heinrich Schwoerer<sup>1</sup>; Karel von Eschwege<sup>2</sup>; Patrizia Krok<sup>1</sup>

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The photoinduced isomerisation reaction of dithizonatephenyl-mercury(II) in solution by femtosecond transient absorption spectroscopy is investigated. The C=N isomerisation from the cis reactant to trans product, results in a significantly red shifted absorption band for the product compared to the reactant. We discuss ultrafast photoinduced isomerisation along a reaction pathway.

238

## Quantum Teleportation with Photons carrying Orbital Angular Momentum

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**Co-authors:** Andrew Forbes<sup>2</sup>; Stef Roux<sup>2</sup>; Thomas Konrad<sup>1</sup>

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In quantum teleportation an unknown quantum state is transferred from one quantum system to another. Here we study a scheme to realise quantum teleportation for qubits with photons carrying orbital angular momentum and discuss the possibility to teleport qutrits.

239

## Computational Study of the Structural and Stability of the Noble Metal Alloys X<sub>3</sub>Al (where X = Pt, Pd, Os, Ir, Rh and Ru)

**Author:** Adewumi Popoola<sup>1</sup>

**Co-author:** John Lowther<sup>2</sup>

<sup>1</sup> School of Physics, University of the Witwatersrand, Johannesburg

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We have used electronic structure method based upon Density Functional Theory (DFT) formalism to search for new class of high temperature super-alloys. Our search is focused on alloys between the noble metals and aluminum. Over-estimation of the properties of our target alloys was avoided by approximating only the gradient of the exchange and correlation functional. The behavior of each alloy to stress was investigated using volume-conserving strains. Our calculation's result predicts that alloys based on iridium (Ir) and rhodium (Rh) should combine good high temperature strength with structural stability.

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## Experiment- A true eye-opener for physics students

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Q Motsoeneng, N C Moji, D Dale, T Hlatshwayo and W Mtangi.

An investigation of what happens to the temperature of a mixture of ice and water at zero degrees celsius when left to heat up on its own. Students only learned later that the heat absorbed was used to break the bonds.

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## Effect of film thickness on pulsed laser deposited optically selective solar absorbers

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**Co-authors:** Andrew Forbes<sup>1</sup>; Ngcali Tile<sup>1</sup>; Roro Kittessa<sup>2</sup>

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Carbon nanotubes embedded in NiO have been ablated onto aluminium by varying deposition time/thickness using pulsed laser deposition for selective solar absorber coatings. It has been noted that the absorbance increases as the thickness increases for all carbon concentrations. A maximum solar absorbance of 91 % has been achieved so far.

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## Primordial Black Holes : Evolution as the Universe Aged

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Primordial black holes are believed to have formed from some of the inhomogeneities in the early universe; unlike astrophysical black holes they exhibit a large range of masses. Their mass relation and evaporation via Hawking radiation was explored and a simulation of their numbers as the universe aged was made

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## Comparisons of HI and CO Dynamics of THINGS Galaxies

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**Co-author:** W.J.G. de Blok<sup>1</sup>

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We present recent results comparing the dynamics of a sample of local galaxies in HI (THINGS) and CO (HERACLES). We will also compare different means of computing velocity fields and verify the interchangeability of HI and CO, especially for the innermost stellar regions, where HI has a very low surface brightness.

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## High Flux Neutron Detection System

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**Co-authors:** Paul Papka<sup>2</sup>; Ricky Smit<sup>3</sup>; Robert Dobson<sup>4</sup>; Shaun Wyngaardt<sup>4</sup>

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A high flux neutron detection system, integrating the neutron converter material <sup>6</sup>Li and <sup>12</sup>C and a highly sensitive mass spectrometer, is been developed to detect slow and fast neutrons. The reaction rates and neutron flux will be deduced from the analysis of the <sup>4</sup>He atoms released with the mass spectrometer.

245

## Influence of Sb doping on grain growth of polycrystalline copper

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**Co-authors:** Joseph Asante<sup>2</sup>; Shaun Cronje<sup>1</sup>; Wiets Roos<sup>1</sup>

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<sup>2</sup> Tshwane University of Technology

Small concentrations of Sb dopant in Cu can increase the grain boundary energy which suppresses grain growth. XRD results show that after annealing the CuSb alloy, the relative intensities of the (111) and (420) orientations increase. The grain growth results indicate that the Sb inhibits grain growth in Cu and keeps the microstructure intact at higher temperatures.

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## Sm<sub>1-x</sub>Nd<sub>x</sub>NiO<sub>3</sub> Thin Films Deposition by KrF laser ablation: Laser fluence optimisation

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**Co-authors:** Malik Maaza<sup>2</sup>; Samira Abdelli-Messaci<sup>1</sup>; Tahar Kerdja<sup>1</sup>; smail Malek<sup>1</sup>

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In this contribution we study the effect of the laser fluence on the stoichiometry and morphology of Sm<sub>1-x</sub>Nd<sub>x</sub>NiO<sub>3</sub> thin films deposited by KrF laser ablation into vacuum. Using an ion probe, the plasma plume front velocity was determined and related to the films properties. Furthermore, the ablated mass was measured and the ablation threshold was determined. Thereby, the optimal laser fluence was set to be in the range of 1 – 2 Jcm<sup>-2</sup>.

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## Multi pass 1.9 um Tm:YLF slab laser pump source

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**Co-authors:** Christoph Bollig<sup>1</sup>; Cobus Jacobs<sup>1</sup>; Dieter Preussler<sup>1</sup>; Kwanele Nyangaza<sup>1</sup>; Oliver Collett<sup>1</sup>; Shaun Burd<sup>2</sup>; Wayne Koen<sup>1</sup>

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A novel multi-pass Tm:YLF laser was demonstrated with an improvement in efficiency, footprint and cost over two diode stack pumped, single pass systems. We report 100 W of output power from 261 W of incident diode pump power with a slope efficiency of 44%.

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## Data Analysis of Time Critical Emission FTIR Measurements of Countermeasure Flares

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<sup>1</sup> CSIR

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Recent emission FTIR measurements were done on countermeasure flares using a passive infrared imaging Fourier transform spectrometer. Problems faced during the data analysis, where part of the data signature is located on dead pixels, and the determination of both temperature and emissivity as unknowns, are discussed.

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## Temperature dependence of current-voltage characteristics of p-silicon Schottky diodes for radiation-hard detectors.

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Current-voltage measurements were carried out on the silicon Schottky diodes in the temperature range of 280–330 K. The results obtained were interpreted in terms of defect levels induced by metal impurities in the energy gap. These levels are responsible for the relaxation behavior of silicon. Properties of these relaxation diodes are not affected by the incident radiation; hence, the diodes are used to devise the radiation-hard detectors.

250

## Laser-induced breakdown spectroscopy for quantification of heavy metals in soils and sediments

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**Co-authors:** Anton Du Plessis<sup>1</sup>; Robert McCrindle<sup>2</sup>

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Laser-induced breakdown spectroscopy (LIBS) will be used to determine the contents of heavy metals in soils and sediments. LIBS results will be compared with the results obtained by inductively coupled plasma-optical emission spectrometry (ICP-OES) and inductively coupled plasma-mass spectrometry (ICP-MS).

251

## Time Scales in Nuclear Giant Resonances

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A many-body approach is used to investigate the regular patterns in scales found in a wavelet analysis of giant resonance fine structure. Our study suggests that the spreading widths of collective excitations in nuclei are determined by the number of fragmentations seen in the power spectrum of the scales.

252

## The influence of the initiating and the annealing temperature on the luminescent and structural properties of BaAl<sub>2</sub>O<sub>4</sub>:Eu<sup>2+</sup>,Nd<sup>3+</sup>,Gd<sup>3+</sup> phosphors prepared by combustion method

**Author:** Bakang Moses Mothudi<sup>1</sup>

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BaAl<sub>2</sub>O<sub>4</sub>:Eu<sup>2+</sup>, Nd<sup>3+</sup>,Gd<sup>3+</sup> phosphors prepared at different initiating combustion temperatures (400-1200 oC) were annealed at 400-1200 oC for 3 hours. X-ray diffraction, SEM, FT-IR and Raman were employed to identify the structural phases, surface morphology and vibrational frequencies, respectively, and a 325 nm He-Cd was used for fluorescence measurements.

253

## Hall effect measurements and surface conduction in bulk melt grown single crystal ZnO

**Author:** Wilbert Mtangi<sup>1</sup>

**Co-authors:** Albert Chawanda <sup>1</sup>; Cloud Nyamhere <sup>2</sup>; Danie F Auret <sup>1</sup>; Jackie Nel <sup>1</sup>; Mmanstae Diale <sup>1</sup>

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Hall effect studies carried out on as-received, melt grown, single crystal ZnO samples show the existence of two shallow donors with energy levels (37.8 ± 0.3) meV and (54.5 ± 0.9) meV. Annealing studies performed on the hydrogen peroxide treated samples reveal the existence of a conductive channel in ZnO.

255

## Development of a high power femtosecond laser

**Author:** Pieter Neethling<sup>1</sup>

**Co-authors:** Erich Rohwer<sup>1</sup>; Heinrich Schwoerer<sup>1</sup>; Lourens Botha<sup>2</sup>

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The Laser Research Institute and the CSIR National Laser Centre are developing a high power femtosecond laser system in a joint project with a phased approach. The laser system consists of a fs oscillator and a regenerative amplifier. An OPCPA amplifier and a multi-pass amplifier are under development.

256

## **Carbon nanotube/nickel oxide nanocomposite thin films for selective solar absorber**

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<sup>1</sup> *NLC-CSIR*

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Multi-walled carbon nanotube (MWCNT)/Nickel oxide nanocomposites were prepared on aluminum substrates for selective solar absorber applications. MWCNTs are functionalized in order to disperse in water and ethanol. Results from the characterization of the composite samples using techniques such as transmission and scanning electron microscopies will be presented and discussed.

257

## **Star formation thresholds in two atypical star-forming dwarfs**

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**Co-authors:** Erwin de Blok<sup>2</sup>; Renee Kraan-Korteweg<sup>2</sup>

<sup>1</sup> *University of Cape Town + South African Astronomical Observatory*

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Star formation is a major driver of galaxy evolution. A suite of star formation models is examined for two atypical star-forming dwarf galaxies in order to quantify the relationships between their star formation activity and the properties of their inter-stellar media. High-quality HI, far infrared and far-ultra violet imaging is used to accomplish this. The star formation threshold of each galaxy is shown to depend on global kinematics as well as the stellar and dark matter potentials. Alternatively, adopting the rotational shear as a characterisation of the global kinematics allows for accurate descriptions of the star formation.

258

## Measurements of the Temperature of the Tungsten Hexa-Ethoxide Pyrolysis Flame using IR Camera

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**Co-authors:** Bonex Mwakikunga<sup>2</sup>; Neels Neels Brink<sup>3</sup>

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In laser pyrolysis, temperature measurement and control plays a vital role during the development of nanoparticles. We present the results of temperature measurements using infrared camera on a tungsten hexa-ethoxide pyrolysis flame used to synthesize nanoparticles from laser pyrolysis technique.

259

## Network knowledge base on low-energy nuclear physics

**Author:** Alexander Karpov<sup>1</sup>

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The project "Knowledge base on low-energy nuclear physics" allocated in the Web solves the two following problems: 1) Fast and visual getting of experimental data on nuclear structure and cross sections of nuclear reactions, a possibility for processing these data, their comparison and plotting the studied regularities and systematizations. 2) Analysis of experimental data and modeling the processes of nuclear dynamics within the foolproof codes based on the well-established physical approaches just in a window of the Web-browser.

260

## The Search for Short Period Transients in XMM-Newton Data

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The XMM-Newton observatory has 10 years worth of data archives. The data is analyzed by a standard pipeline that does not search for transients. I researched into three different methods which would search for transients and found that the Kuiper test was the most sensitive.

261

## Determination of the Emissivity of Tungsten Hexa-Ethoxide Pyrolysis Flame using Fourier Transform Infrared (FTIR) Spectroscopy

**Author:** Azwitamisi Eric Mudau<sup>1</sup>

**Co-authors:** Andrew Forbes<sup>2</sup>; Bonex Mwakikunga<sup>2</sup>; Cornelius Willers<sup>1</sup>; Lerato Shikwambana<sup>2</sup>; Malcolm Govender<sup>2</sup>; Neels Brink<sup>3</sup>

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To determination the temperature using infrared cameras, the following issues need to be addressed, the emissivity of the object and atmospheric path effects. The later is negligible in the setup used. In this paper we present the emissivity of the flame determined from the transmissivity measured using the FTIR Spectroscopy.

262

## Do (anti)neutrinos influence radioactive decay rates?

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A recent paper by Jenkins et al. suggested that the radioactive decay rate of certain radionuclides may be influenced by the neutrino flux from the Sun which varies with the distance between the Sun and Earth. This paper reports on measurements made at a reactor to test this claim.

263

## Temperature measurements of C-NiO sol-gel composite films using a negative temperature coefficient (NTC) thermistor

**Authors:** Mapule DeGama<sup>1</sup>; Thobeka Wittes<sup>1</sup>

**Co-authors:** Andrew Forbes<sup>1</sup>; Ted Roberts<sup>1</sup>

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Sol-gel technique was used for fabrication of C-NiO coatings. These coatings are used as selective solar absorbers for solar water heating purposes. A home-test facility was built to test the absorption efficiency of C-NiO coatings, and performances of these coatings were compared to black-paint coating and a non-coated aluminium plate.

264

## Pulse shaping and characterization with a 4f system

**Author:** Nicolene Botha<sup>1</sup>

**Co-authors:** Anton du Plessis<sup>2</sup>; Heinrich Schwoerer<sup>3</sup>; Hermann Uys<sup>2</sup>; Lourens Botha<sup>2</sup>

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<sup>3</sup> LRI

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The design of the pulse shaping setup as well as factors taken into account in choosing a specific setup will be discussed. We investigate the generation of simple shaped pulses to test our pulse shaper setup. Difference frequency mixing is used to transfer the pulse shape to the mid-infrared regime.

265

## The Stability of High Pressure Phase of B<sub>2</sub>O<sub>3</sub>

**Authors:** Jacob Moloantoa<sup>1</sup>; Thuto Mosuang<sup>1</sup>

**Co-author:** Erasmus Rammutla<sup>1</sup>

<sup>1</sup> University of Limpopo

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The stability of boron trioxide is studied using the plane wave's pseudopotentials calculations. The hydrostatic pressure against volume at room temperature is being varied to determine the minimum energy possible for phase transformation. Our results agree well with various boron trioxide calculations and experiments.

266

## Radiometric analysis of canned fruit sample by Gamma-ray spectrometry

**Author:** Lungiswa Ziwani<sup>1</sup>

**Co-authors:** I.N Hlatshwayo<sup>2</sup>; P.P. Maleka<sup>2</sup>; R.T. Newman<sup>2</sup>; T Mufhadi<sup>2</sup>

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Samples of canned fruits were liquidised and counted using a HPGe detector system. The acquired gamma-ray spectra were analysed for traces of <sup>137</sup>Cs <sup>40</sup>K radionuclides and determining the activity concentrations in the samples Results of a detailed investigation optimisation of the methodology limits will be presented for reference material.

267

## Towards the all-optical determination of temperatures in invisible plumes by infrared thermography and in-situ IR spectroscopy during the CO<sub>2</sub> laser pyrolysis of metallorganic droplets

**Author:** Bonex Mwakikunga<sup>1</sup>

**Co-authors:** Andrew Forbes<sup>1</sup>; Azwitamisi Mudau<sup>2</sup>; Elias Sideras-Haddad<sup>3</sup>; Lerato Shikwambana<sup>1</sup>; Malcolm Govender<sup>1</sup>; N Williers<sup>2</sup>

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We report on the first online observation of invisible plumes in the CO<sub>2</sub> laser system by use of a CEDIP Instruments Inc. infrared camera. Examples of movie clips of the flame are presented. We also present results of ingenious experiments on spectroscopy of such flames by means of an RS Series of the BOMEM FTIR employing two types of the Cincinnati Electronics Laboratories IR detectors operating at liquid nitrogen temperature. The spectra show new absorption peaks. Temperatures vs laser power and vs laser wavelength are presented

268

## Spray deposition of C-NiO thin films for selective solar absorber applications

**Author:** Ngcali Tile<sup>1</sup>

<sup>1</sup> CSIR NLC

C-NiO was spray deposited on large scale aluminium substrate for use as cost-effective selective solar absorbers. These films were characterized structurally and optically. Absorptance of up to 0.8 calculated from UV/Vis spectrophotometry was achieved on these coatings. Their SEM images revealed pores while Raman revealed presence of predominantly graphite carbon.

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## Optimization of a Ho<sup>3+</sup>:YLF amplifier model

**Author:** oliver collett<sup>1</sup>

**Co-authors:** Christoph Bollig<sup>1</sup>; Daniel Esser<sup>1</sup>

<sup>1</sup> National Laser Center

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A laser amplifier model was produced for Ho<sup>3+</sup>:YLF and used for parametric optimization of the amplifier gain. The interaction is approximated with a rate equation approach. A maximum gain of 2.3 in energy was recorded for the particular model configuration.



270

## Status of the iThemba LABS radioactive beam project

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A proposal to develop a radioactive beam facility at iThemba LABS is being developed. It envisages the addition of a new cyclotron, a k70 negative-ion accelerator. Such an accelerator can supply two beams simultaneously, one to be used for isotope production and neutron therapy, the other to create radioactive ions. These can be post accelerated by the existing SSC accelerator to energies of 5~7 MeV/A. It is envisaged that the beamtime available for nuclear physics, presently restricted to weekends only, will more than double.

271

## Fine Structure of the Isovector Giant Dipole Resonance: a survey with (p,p') scattering at zero degrees

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**Co-authors:** Anna-Maria Heilmann<sup>2</sup>; Atsushi Tamii<sup>3</sup>; Dirk Fourie<sup>4</sup>; Elias Sideras-Haddad<sup>1</sup>; Iryna Poltoratska<sup>2</sup>; Iyabo Usman<sup>4</sup>; Joel Mira<sup>5</sup>; John Carter<sup>1</sup>; Paul Papka<sup>5</sup>; Peter von Neumann-Cosel<sup>2</sup>; Retief Neveling<sup>4</sup>; Ricky Smit<sup>4</sup>; Roger Fearick<sup>6</sup>; Sean Murray<sup>4</sup>; Siegfried Fortsch<sup>4</sup>; Zinhle Buthelezi<sup>4</sup>

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A survey of the fine structure of the Isovector Giant Dipole Resonance (IVGDR) was investigated using the newly commissioned zero degree capability of the K = 600 magnetic spectrometer of iThemba LABS. Scattering (p,p') data were obtained over a wide target-mass range, at 200 MeV. Experimental techniques and preliminary results are presented.

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## A survey of the experience of selected first year engineering students at the University of Pretoria

**Author:** Diane Grayson<sup>1</sup>

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In 2009 the first cohort of students who wrote the new National Senior Certificate entered South Africa's universities. Failure rates in the first semester in the sciences were higher than before. A survey conducted with students who moved from BEng to the 4-year BSc reveals what students saw as problems.

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## **Nature of phonon confinement and phonon splitting in V<sub>2</sub>O<sub>5</sub> and VO<sub>2</sub> bi-layered nano-ribbon grown by ultrasonic spray pyrolysis**

**Author:** Bonex Mwakikunga<sup>1</sup>

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Raman spectroscopy of the nano-ribbons, about 10 nm thick as found by AFM, is discussed in the framework of the Richter equation for phonon confinement (1) as modified for thin films by Faucet & Campbell, (2) as modified by Kim et al<sup>2</sup> for slabs and (3) our own modification based on the transformation from the spherical coordinates in the Richter equation to Cartesian coordinates; this being in keeping with the ribbon geometry. For ribbons whose thickness is too small for phonon confinement models, phonon splitting is observed and this is explained in terms of Lermann et al<sup>3</sup> and Volodin et al<sup>4</sup> formalisms.

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## **A description of the University of Pretoria's Engineering Augmented Degree Programme**

**Author:** Diane Grayson<sup>1</sup>

<sup>1</sup> *University of Pretoria*

For many years only about 1/3 of the students who registered for a BEng obtained their degree in four years. Since 1994 a minority of students were registered for a 5-year programme that spread two years over three. But most of these students took longer. In 2010 a new, carefully structured 5-year degree is being offered.

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## **Versatile Interferometer System for Inscription of Fiber Bragg Gratings**

**Authors:** Johan Meyer<sup>1</sup>; Rodolfo Martinez<sup>1</sup>; Ruan Du Toit<sup>2</sup>

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In this paper we describe the hardware, software control and experimental results for an interferometric Bragg writing setup at various written wavelengths within the 1550nm and 1310nm telecommunication windows.

276

## Electrical characterization of ruthenium and Iridium Schottky contacts on n-Ge (100)

**Author:** Albert Chawanda<sup>1</sup>

**Co-authors:** C Nyamhere<sup>2</sup>; F.D Auret<sup>1</sup>; J.M. Nel<sup>1</sup>; M Diale<sup>3</sup>; S.M.M Coelho<sup>1</sup>; W Mtangi<sup>1</sup>

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Ruthenium (Ru) and Iridium (Ir) Schottky barrier diodes were electron beam deposited on (100) n-type germanium. Electrical characterization of these contacts using current-voltage and capacitance-voltage measurements was performed under various annealing conditions. The variation of the electrical properties of these Schottky contacts can be attributed to the combined effects of interfacial reactions and phase transition during the annealing process.

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## One parameter scaling for the massive Dirac equation with scalar disorder.

**Author:** Izak Snyman<sup>1</sup>

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A massive two dimensional Dirac particle in a random electrostatic potential is considered. For a ribbon geometry (width  $\ll$  length), the Lyapunov exponent is calculated as a function of ribbon width, for several energies and disorder strengths. Intriguingly, an attempt to demonstrate one parameter scaling is only partially successful.

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## Habitable Zones in the Universe and Around Stars with Discovered Exoplanets

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The habitability zone is a region where planets can form with suitable conditions for life, these regions can be localized to galactic habitability zones and circumstellar habitability zones. These will be discussed along with the application of habitability models around stars to the planetary systems that have been discovered.

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## Development of $^9\text{Be}$ beam and measurement of $^9\text{Be} + ^9\text{Be}$ elastic scattering at iThemba LABS (Gauteng)

**Author:** Innocent Mayida<sup>1</sup>

**Co-authors:** Elias Sideras-Haddad<sup>2</sup>; John Carter<sup>2</sup>

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The 6 MV EN tandem accelerator of iThemba LABS (Gauteng) will be used for the measurement of  $^9\text{Be} + ^9\text{Be}$  elastic scattering. An excitation function and an angular distribution will be measured. The beam development exercise, experimental techniques and new results will be presented.

280

## Single Frequency $2\mu\text{m}$ MOPA delivering 200mJ at 50Hz

**Author:** Cobus Jacobs<sup>1</sup>

**Co-authors:** Christoph Bollig<sup>1</sup>; Daniel Esser<sup>1</sup>; Dieter Preussler<sup>1</sup>; Hencharl Strauss<sup>1</sup>; Kwanele Nyangaza<sup>1</sup>; Oliver Collett<sup>1</sup>; Wayne Koen<sup>1</sup>

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We present a high energy master oscillator power amplifier consisting of a Holmium-doped slab amplifier, a diode-pumped Thulium-slab pump laser, and a single frequency Ho:YLF ring seed laser. The amplifier delivered up to 210 mJ at 2064 nm with a beam quality factor of  $M^2 \leq 1.4$  in both planes.

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## The confinement of Graphene nanosheets in an isolated one dimensional system

**Author:** MOHAMMED KHENFOUCH<sup>1</sup>

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With freakishly mobile electrons that can blaze through the material at nearly the speed of light, 100 times faster than electrons can move through silicon, and its amazing mechanical properties,

graphene became the rise of future mecha and optoelectronic. The main goal of this work is to confine Graphene nanosheets in polymeric 1-D systems.

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## **Pump-Probe Spectroscopy of photo induced charge transfer in Zinc Phthalocyanine - Carbon Nanotube donor-acceptor pairs**

**Author:** Egmont Rohwer<sup>1</sup>

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Various derivatives of a zinc phthalocyanine molecule, covalently linked or adsorbed to the surface of carbon nanotubes, are excited at their respective absorption bands to subsequently monitor transmission changes with a delayed probe pulse. The aim is to identify charge separated states, their lifetimes and the pathway of the induced photoreaction.

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## **Ultrafast Transient Absorption Spectroscopy at the LRI**

**Author:** Egmont Rohwer<sup>1</sup>

<sup>1</sup> *Stellenbosch University*

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A detailed overview of the current UTA setup at the LRI is presented in poster format. Specific attention is given to the improvements and alterations made in the past year that has allowed for increased sensitivity, spectral versatility, temporal resolution and operational reliability.

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## **Study of Alpha Decay for Heavy and Superheavy Nuclei**

**Author:** Tinyiko Maluleke<sup>1</sup>

**Co-author:** Alexander Karpov<sup>2</sup>

<sup>1</sup> *Student*

<sup>2</sup> *Researcher*

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Alpha decay characteristics (ground-state masses, Q-values, decay lifetimes and nuclear potentials) have been studied extensively using various methods and models. A computer visualization code will be developed and tested on available experimental data and make predictions for experimentally unexplored region. The final product will be incorporated into low-energy nuclear database.

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## **Antisymmetrised Molecular Dynamics For Realistic Nucleon-Nucleon Potentials**

**Author:** Gaotsiwe Joel Rampho<sup>1</sup>

<sup>1</sup> *University of South Africa*

A technique of approximating expectation values of realistic nuclear Hamiltonian with the antisymmetrised molecular dynamics wave function is presented. Phenomenological nucleon-nucleon potentials with analytical expectation values are used for illustration. The results obtained with the approximation are compared with those obtained with analytical evaluation.

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## **Structure of Light Nuclei Studied with Antisymmetrised Molecular Dynamics**

**Author:** Gaotsiwe Joel Rampho<sup>1</sup>

<sup>1</sup> *University of South Africa*

Ground-state properties and cluster structure of Helium and Beryllium nuclei are studied with the antisymmetrised molecular dynamics. The Hamiltonian of the nuclei is described with a semi-realistic nucleon-nucleon potential. The results obtained are compared with experimental data

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## **Charge Form-Factors of Light Nuclei Studied with Antisymmetrised Molecular Dynamics**

**Author:** Gaotsiwe Joel Rampho<sup>1</sup>

**Co-author:** Sofianos A. Sofianos <sup>1</sup>

<sup>1</sup> *University of South Africa*

Charge form-factors of three- and four-nucleon systems are extracted from elastic electron scattering using antisymmetrised molecular dynamics wave functions. The Hamiltonian of the nuclei is described with a semi-realistic nucleon-nucleon potential. The results obtained are compared with some experimental data.

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## **Test of Fast Neutron Detectors for Spectroscopy**

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A large volume neutron detector was developed to investigate the very selective ( $3\text{He},n$ ) reaction. The performance of the detector was tested using muon cosmic rays and neutrons emitted from the  $^{232}\text{Th}(4\text{He},xn)$  reaction.

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## **Thermal performance of a Photovoltaic water heating system (PVWHS)**

**Author:** Busiso Mtunzi<sup>1</sup>

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The efficiency of photovoltaic module is largely affected by high operating temperatures. This paper discusses the effect of a batch water system on a SP70 photovoltaic module. Heat exchange in the system was noted to take place. Infrared camera, PVP1000C device, thermocouples and a data logger were used for data collection.

290

## **Design of anaerobic digester with automatic temperature control**

**Author:** Felix Pagona<sup>1</sup>

<sup>1</sup> *Fort Hare Institute of Technology, Physics Department*

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Unnecessary temperature fluctuations due to factors such as self heating effect adversely affect performance and stability of anaerobic digesters [1]. A digester will be designed with an automatic temperature regulation mechanism that incorporates sensors, temperature regulator and cooling/heating system, which will be triggered into action upon receiving sensor instructions resulting from detection of unnecessary temperature fluctuations.

291

## **The mechanical stability of PtTi in terms of their heats of formations, phonon dispersions and density of states**

**Author:** Rosinah Mahlangu<sup>1</sup>

**Co-authors:** Hasani Chauke<sup>1</sup>; Maje Phasha<sup>2</sup>; Phuti Ngoepe<sup>1</sup>

<sup>1</sup> *University of Limpopo*

<sup>2</sup> *CSIR*

We investigate the transformation from B2 to B19/B19' in the PtTi shape memory alloys using density functional theory within the generalized gradient approximation, VASP code [1]. We will present the results on the heats of formation, phonon dispersions and the density of states for the B2, L10, B19 and B19' PtTi structures. Furthermore, we calculated the lattice expansion for the B2 and L10 PtTi structures.

292

## Hydrogen Sensing Behaviour of WO<sub>3</sub> Nanoplatelet Films Synthesized by Aqueous Chemical Growth

**Author:** Bertrand SONE<sup>1</sup>

<sup>1</sup> *iThemba LABS-UWC*

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We report for the first time the synthesis of WO<sub>3</sub> nanostructured fairly-thin films on transparent glass substrates, this by the low-temperature soft chemistry method of Aqueous Chemical Growth<sup>3</sup>. The films obtained were structurally and optically characterized. Results on these as well as those on their Hydrogen sensing behaviour as a function of temperature and H<sub>2</sub> concentration (in ppm) are reported.

293

## Modelling of the reaction mechanism during laser assisted conversion of methane and carbon dioxide

**Author:** FJ Kotze<sup>1</sup>

**Co-authors:** A Du Plessis<sup>2</sup>; CA Strydom<sup>1</sup>; G Lachman<sup>3</sup>; L Botha<sup>4</sup>

<sup>1</sup> *North-West University*

<sup>2</sup> *Centre for Scientific and Industrial Research; North-West University*

<sup>3</sup> *Nort-West University*

<sup>4</sup> *Centre for Scientific and Industrial Research*

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The direct excitation of CO<sub>2</sub> and CH<sub>4</sub> using a nanosecond pulsed laser was investigated for chemical reaction activation. Results from this study show that carbon dioxide and methane can be activated successfully using nanosecond laser pulses at 355 nm. The results collected from the various experiments were used to create a model of the possible reaction mechanisms using Molecular Modelling.

294

## Computer Controlled DLTS Offset Capacitor System

**Author:** Hannes de Meyer<sup>1</sup>



<sup>1</sup> *University of Pretoria*

**Corresponding Author:** 1unidade@gmail.com

An offset capacitor system is used to reduce the signal to noise ratio when measuring capacitance transients in Deep Level Transient Spectroscopy (DLTS) to subtract the equilibrium capacitance of the sample. A LabVIEW routine in conjunction with a computer controlled offset capacitance box was build and compared with a standard set capacitor box.

295

## **Observing structural dynamics of solid state matter with ultra-fast electron diffraction**

**Author:** Gunther Kassier<sup>1</sup>

<sup>1</sup> *Stellenbosch University*

**Corresponding Author:** kassier@sun.ac.za

We have constructed an Ultrafast Electron Diffraction setup suitable for studying femtosecond time resolved structural dynamics in solid state matter. The setup has been characterized with respect to its spatial and temporal resolution capability, and measurements confirm that sub-300 femtosecond electron pulses with sufficient spatial resolution capability are achievable.

296

## **CL stability and surface chemical changes of ZnAl<sub>2</sub>O<sub>4</sub>:Mn nanocrystalline phosphor**

**Author:** SS Pitale<sup>1</sup>

**Co-authors:** OM Ntwaeaborwa<sup>1</sup>; Vinay Kumar<sup>1</sup>

<sup>1</sup> *University of the Free State*

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Luminescence characteristics and surface chemical changes of nanocrystalline Mn doped ZnAl<sub>2</sub>O<sub>4</sub> powder phosphors are presented. X-ray photoelectron spectroscopy (XPS) was used to determine the chemical composition of the possible compounds formed on the surface as a result of the prolonged electron beam exposure. A stable Al<sub>2</sub>O<sub>3</sub> layer was formed on the surface and is possibly contributing to the CL stability of the ZnAl<sub>2</sub>O<sub>4</sub>:Mn phosphor.

297

## **Comparison study of polycrystalline and single crystal CeAuGe**

**Author:** Buyisiwe Sondezi-Mhlongu<sup>1</sup>

**Co-author:** Andre M. Strydom<sup>1</sup>

<sup>1</sup> *University of Johannesburg*

The magnetic and electronic properties of polycrystalline and single crystal CeAuGe were investigated from magnetic susceptibility and resistivity measurements. Theoretical resistivity fits describing anisotropic ferromagnetism in the ordered region were performed and illustrates how the energy gap in the magnon excitation spectrum decreases as a function of applied magnetic field.

298

## **Vortex Array Oscillations and Their Quantization With Reference to Neutron Stars**

**Author:** Garreth Kemp<sup>1</sup>

**Co-authors:** Christian Engelbrecht<sup>1</sup>; Fabio Frescura<sup>2</sup>

<sup>1</sup> *University of Johannesburg*

<sup>2</sup> *University of the Witwatersrand*

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We investigate the canonical quantization of axial and Tkachenko oscillation modes of a vortex lattice in a rotating superfluid. We explore possible links between classical vortex theory and the works of Fetter and Owczarek & Slupski. This investigation may be relevant to the timing and glitch behaviour of neutron stars.

299

## **Exergy analysis of a building integrated photovoltaic (BIPV) generator of an energy efficient house**

**Author:** Sosten Ziuku<sup>1</sup>

<sup>1</sup> *SAIP*

**Corresponding Author:** sziuku@ufh.ac.za

In this paper, electrical and exergy analysis of a BIPV generator is presented. Electrical efficiency was found to vary between 13.9% and 17.6% while the indoor Exergy varied from 25.1% to 35.2% between 0900 and 1630hours. Exergy analysis, which deals with maximum energy available from the BIPV generator, gives a more realistic model of the impact that integrated photovoltaic panels have on the built environment.

301

## **Quantitative Investigation of Cu/In thin Films Deposited onto SiO<sub>2</sub> by Electron Beam Evaporation**

**Author:** Moshawe Maditi<sup>1</sup>

**Co-authors:** HC Swart<sup>1</sup>; JJ Terblans<sup>1</sup>

<sup>1</sup> *UFS*

**Corresponding Author:** terblansjj@ufs.ac.za

Thin In/Cu films were grown on a SiO<sub>2</sub> substrate. Both In and Cu layers were grown by e-beam evaporation. The films were characterized with X-ray Diffraction (XRD) and Auger Electron Spectroscopy (AES). The In diffused into the Cu layer during evaporation and formed two intermetallic Cu<sub>11</sub>In<sub>9</sub> and CuIn<sub>2</sub> phases.

302

## Recent developments in asteroseismology

**Author:** Christian Engelbrecht<sup>1</sup>

**Co-author:** Fabio Frescura<sup>2</sup>

<sup>1</sup> *University of Johannesburg*

<sup>2</sup> *University of the Witwatersrand*

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Asteroseismology has evolved into a very active research field in stellar astrophysics. The data from a number of recent ground-based surveys and various satellite missions are opening new windows into our understanding of stellar interiors and dynamics. Some of the more prominent new insights are reviewed.

303

## Particle multiplicities at RHIC using transport model

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<sup>1</sup> *University of Cape Town*

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Ultrarelativistic heavy ion collisions are useful “tools” to investigate the hot and dense nuclear matter. Particle abundances and ratios have been suggested as possible signatures for exotic states and phase transitions in dense nuclear matter. We used a microscopic transport model to calculate the particle ratios and multiplicities from Au-Au collisions, and compared the preliminary results with the statistical model.

304

## Demonstration of a Hybrid Ho:YLF Ho:LuLF Slab Laser

**Author:** M J Daniel Esser<sup>1</sup>

**Co-authors:** Christoph Bollig<sup>1</sup>; Oliver Collett<sup>1</sup>

<sup>1</sup> *CSIR National Laser Centre*

**Corresponding Author:** desser@csir.co.za

We present a continuous-wave slab laser utilising both Ho:YLF and Ho:LuLF as laser gain media. 30 W of output power at 2  $\mu\text{m}$  was demonstrated in a stable concave-plane resonator while 13 W was achieved in a hybrid stable-unstable configuration when pumped with a high-power Tm:YLF slab laser.

305

## **Elastic constants of single crystal InAs<sub>0.91</sub>Sb<sub>0.09</sub> determined by surface Brillouin scattering**

**Author:** Lesias Kotane<sup>1</sup>

**Co-authors:** Arthur Every<sup>1</sup>; Darrell Comins<sup>1</sup>; Reinhardt Botha<sup>2</sup>

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Surface Brillouin scattering is used to determine the velocities of the Rayleigh surface wave, pseudo-surface wave and longitudinal lateral wave measured in the [100] and [110] directions in a (100) surface of single crystal InAs<sub>0.91</sub>Sb<sub>0.09</sub>. Explicit secular functions for the wave velocities are used to extract the elastic constants.

306

## **Contactless Power Transfer for Through-Bore Structures - A Study of Rotary Transformers and Capacitors as Probable Avenues**

**Author:** GLADYS SONKO<sup>1</sup>

**Co-authors:** HENDRIK THERON<sup>1</sup>; YAZEED SCHLOSS<sup>1</sup>

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Contact slip rings have inherent characteristics, e.g. contact wear, that hinder their performance. Alternatives include is the use of inductive or capacitive energy storage for contactless power transfer. We investigated the capacitor as an alternative to the standard inductive type contactless slip rings. The resultant prototype system achieves rotary capacitive power transfer at a system efficiency of 17%.

307

## **Mr**

**Author:** Mpiana Mulamba Florimond Eugène<sup>1</sup>

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<sup>1</sup> *Institut of Theoretical Physics, Department of Physics, Stellenbosch University*

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The partition function for a single polymer winding around a fixed long rod is calculated. The topological invariance for the system is maintained by modelling the polymer as a sequence of connected flexible chains from which Reidemester moves are applied to enumerate all the accessible conformations.

308

## **Forward and Single-Ended Polarization Mode Dispersion Measurements on a Tunable PMD Emulator**

**Author:** Samuel Kofi Fosuhene<sup>1</sup>

<sup>1</sup> *Nelson Mandela Metropolitan University*

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Forward and single-ended Polarization Mode Dispersion (PMD) measurements were performed on a tunable PMD emulator. Selected voltages applied to seven electro-optic polarization rotators altered the mode coupling angles between fixed length polarization maintaining fibres thus changing the emulator's PMD statistics to mimic different fibre links.

309

## **Some Recent Developments In The Theory of Stellar Convection**

**Author:** Sashin Moonsamy<sup>1</sup>

**Co-authors:** Chris Engelbrecht <sup>2</sup>; Fabio Frescura <sup>1</sup>

<sup>1</sup> *University of the Witwatersrand*

<sup>2</sup> *University of Johannesburg*

We review the essential ingredients of Mixing Length Theory and comment on its effectiveness in modeling stellar convection. We discuss also a competing theory of convection known as the Full Spectrum of Turbulence model, and compare it with Mixing Length Theory. We consider some numerical procedures involved in the implementation of these theories.

310

## **Ab-initio modelling of the electronic and annealing properties of low temperature irradiation-induced defects in silicon and germanium**

**Author:** Walter Meyer<sup>1</sup>

**Co-authors:** Danie Auret <sup>1</sup>; Jacq Crous <sup>1</sup>; Jacques Pienaar <sup>1</sup>; Johan Janse van Rensburg <sup>1</sup>; Nithaya Chetty <sup>1</sup>

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The electronic and annealing properties of primary radiation induced defects in Si have been studied by means of density functional theory (DFT) calculations using VASP. The results obtained for different functionals have been compared with each other, with results obtained by other groups and where data is available, to experimental values.

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**Dr**

**Author:** Fabio Frescura<sup>1</sup>

**Co-author:** Chris Engelbrecht<sup>2</sup>

<sup>1</sup> *U Witwatersrand*

<sup>2</sup> *U Johannesburg*

Lie Derivatives and Perturbation of Fluid Flows

We describe the use of the Lie derivative for describing perturbations of fluid flows. We apply the methods developed to some elementary problems in the stability of stellar structure, and discuss the advantages and disadvantages of this approach compared with the standard theory.

312

## **Transport and magnetic properties of the rare earth intermetallic cage compounds Sm<sub>3</sub>Ru<sub>4</sub>Ge<sub>13</sub>**

**Author:** SARIT KUMAR GHOSH<sup>1</sup>

**Co-author:** A. M. STRYDOM<sup>1</sup>

<sup>1</sup> *UNIVERSITY OF JOHANNESBURG*

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We present electrical resistivity and dc susceptibility measurements in the range of 1.8-300K on cubic Sm<sub>3</sub>Ru<sub>4</sub>Ge<sub>13</sub> semiconducting system. At higher temperature the resistivity follows activation type behavior and at lower temperature the onset of antiferromagnetic ordering at T<sub>N</sub> = 5K. On the other hand the susceptibility measurement behaves as a Van-Vleck type paramagnet towards higher temperature 240 < T < 400K and modified Curie-Weiss type behavior between 10 < T < 240, which corresponds to the excited states J=5/2 and J=3/2 above T<sub>N</sub> respectively, under crystal-field interaction.

313

## **Implementation of energy dispersive X-ray fluorescence (EDXRF) techniques for rock art painting analysis at iThemba Labs**

**Author:** Ruan Steyn<sup>1</sup>

<sup>1</sup> *Stellenbosch University*

**Corresponding Author:** swsteyn@telkomsa.net

The complementary use of PIXE (particle induced X-ray emission) and EDXRF (energy dispersive X-ray fluorescence) techniques which was implemented to reduce the analysis time at the Van der Graff accelerator (iThemba Labs). Preliminary results of the rock art elemental composition will be presented.

314

## **Stellar Masses of Star Forming Galaxies in Cluster**

**Author:** Solohery M. Randriamampandry<sup>1</sup>

**Co-author:** S. M. Crawford<sup>1</sup>

<sup>1</sup> *South African Astronomical Observatory*

**Corresponding Author:** solohery@sao.ac.za

We carry out a chi-square fitting of Spectral Energy Distributions (SEDs) for a set of 25 star forming galaxies in the X-ray luminous cluster MS 0451.6-0305 at  $z=0.54$ . We determine the best-fit parameters to get clues on stellar populations and physical properties of these galaxies. It shows that derived stellar masses are in good agreement with previous estimates from the literature. However, further analysis is needed, including using different stellar population models, to refine the uncertainties in the stellar mass estimate.

315

## **Influence of signal input states of polarization on Raman amplification gain in single mode fibres**

**Author:** Kennedy Muguro<sup>1</sup>

**Co-authors:** Andrew Leitch<sup>2</sup>; Jesman Changundega<sup>2</sup>

<sup>1</sup> *Department of Physics, Nelson Mandela Metropolitan University*

<sup>2</sup> *Physics Department, Nelson Mandela metropolitan University*

Raman gain in fibres of low polarization mode dispersion (PMD) depend on the state of polarization (SOP) of the input signal. During forward pumping a large gain variation is observed for certain SOPs when fibre PMD coefficient is below 0.03 pskm<sup>-1/2</sup>. The gain difference is small for fibres of relatively high PMD parameter.

316

## **Measurements of Boat Motion in Waves at Durban Harbour for Qualitative Validation of Motion Model**

**Author:** Oreabetsoe Mosikare<sup>1</sup>

**Co-authors:** Nico Theron<sup>2</sup>; Willem Van der Molen<sup>1</sup>

<sup>1</sup> *Council for Scientific and Industrial Research*

<sup>2</sup> *University of Pretoria*

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The Response Amplitude Operator (RAO) theory was used to develop a mathematical model of boat angular motion. Measurements were made on a harbour patrol boat on sea runs off Durban Harbour. Measurements were first calibrated for axis alignment and then analysed using power spectral density techniques. An estimated roll radius of gyration of 0.4 times the breadth of the vessel was used in the model. Comparison of the measurements to the model shows some correspondence in the frequencies present in the spectra. Discrepancies arise, however, in the spectral power values. The model could be improved by parameter optimisation.

317

### **Dependence of the Degree of Polarization of a Probe Signal on the Pump Wavelength in a Wavelength Division Multiplexed System**

**Author:** Jesman Changundega<sup>1</sup>

**Co-author:** Kennedy Muguro<sup>1</sup>

<sup>1</sup> *Nelson Mandela Metropolitan University*

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For the monitoring of a probe's degree of polarization (DOP), the probe wavelength in a pump-probe Wavelength Division Multiplexed system was fixed while the pump wavelength was varied. Results show the changes in the probe's (DOP). The minimum DOP over the spectrum for varying Pump power was also analyzed.

318

### **Potential relationship between high energetic particle precipitation over the South Atlantic Magnetic Anomaly and mid-latitude ionospheric scintillation observations – implications to South Africa's SKA bid.**

**Author:** Ben Opperman<sup>1</sup>

**Co-author:** Pierre Cilliers<sup>1</sup>

<sup>1</sup> *Hermanus Magnetic Observatory*

South Africa's bid to host the Square Kilometre array (SKA) radio telescope pivots around a number of crucial factors, including the local ionospheric stability. This study investigates the effects of high energetic, electrically-charged particle precipitation over the South Atlantic Magnetic Anomaly on the stability of the South African ionosphere.

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### **MICRORODS AND NANOPATELETS-BASED SENSORS**

**Author:** Joseph Sithole<sup>1</sup>

**Co-authors:** Dirk Knoesen<sup>2</sup>; Malik Maaza<sup>1</sup>; Mlungisi Nkosi<sup>1</sup>; Remy Bucher<sup>1</sup>; Saleh Khamlich<sup>3</sup>



<sup>1</sup> NRF *iThemba Labs*

<sup>2</sup> *University of Western Cape*

<sup>3</sup> *Tshwane University of Technology*

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The optimized and fabricated Zinc Oxide (ZnO) microrods and platelets-based nanostructures were generated using hydrolysis-condensation at mild temperatures. The targeted applications are geared towards ultrasensitive H<sub>2</sub> sensors with detection efficiency as low as 2 ppm. The synthesis and optimization strategy as well as experimental results on hydrogen gas sensing are presented.

320

## **Porphyrin nanorods characterization for an artificial light harvesting and energy transfer system**

**Author:** Nametso Mongwaketsi<sup>1</sup>

**Co-authors:** Bert Klumperman<sup>2</sup>; Malik Maaza<sup>1</sup>; Raymond Sparrow<sup>3</sup>

<sup>1</sup> *iThemba LABS*

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Understanding growth mechanism of porphyrins nanorods by self assembly and molecular recognition is essential for their successful implementation in nanodevices. Optical spectroscopy and FTIR were used to investigate growth mechanism immediately after mixing and onwards. These porphyrins nanorods can be organized into structures performing essential light-harvesting and energy transfer roles.

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## **Low temperature H<sup>+</sup> irradiation and in situ DLTS measurements on ZnO**

**Author:** Johan Janse van Rensburg<sup>1</sup>

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Semiconductor materials have been irradiated with 1.6 MeV protons at a temperature of 25 K after which in situ electrical characterization was performed to study the electrical active defects created during the irradiation. High resolution Laplace-DLTS was used to determine activation energies, capture cross-sections, defect concentrations and defect annealing kinetics.

322

## **Unidentified EGRET Blazar Candidates**

**Author:** Pheneas Nkundabakura<sup>1</sup>

**Co-author:** Pieter Meintjes <sup>1</sup>

<sup>1</sup> *University of the Free State*

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The Large Area Telescope (LAT) on board the Fermi/GLAST gamma-ray observatory is a pair conversion gamma-ray telescope sensitive to photon energies between 20 MeV and 300 GeV. With its high sensitivity in point source detection, 25 times more than its predecessor the EGRET, and its improved source localisation, Fermi-LAT has shown that it will address some of the unresolved issues left behind by EGRET. In this paper, we report the multi-wavelength properties of the 4 sources detected by Fermi-LAT from our sample of study of high galactic latitudes sources, possibly associated with blazars, selected among the unidentified EGRET sources.

323

## Probing the epistemology of senior physics students using EBAPS

**Author:** VICTORIA NWOSU<sup>1</sup>

**Co-author:** Allie Saalih <sup>1</sup>

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EBAPS, a forced-choice instrument designed to probe students' epistemologies, their views about the nature of knowledge and learning in the physical sciences, was administered to groups of senior physics student. The results from preliminary analysis for a group of postgraduate students are presented together with some response data from interviews.

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## Temperature dependence ESR study of Cr<sub>2</sub>O<sub>3</sub>.nH<sub>2</sub>O nano-particles

**Author:** Saleh Khamlich<sup>1</sup>

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In view of devising Chromium III Oxide based photothermal absorbers, the quasi-spherical nano-particles of Cr<sub>2</sub>O<sub>3</sub>.nH<sub>2</sub>O have been synthesized by hydrothermal process. An anomalous thermal hysteresis was detected on Cr<sub>2</sub>O<sub>3</sub>.nH<sub>2</sub>O by using the Electron Spin Resonance Spectroscopy at X-band (9.61 GHz) in the temperature range of 292K–420K. Differential scanning calorimetry (DSC), was used in addition to shed light of the presence of the anomalous thermal hysteresis on Cr<sub>2</sub>O<sub>3</sub>.nH<sub>2</sub>O nano-particles.

325

## Thin film analysis by Time of Flight– Elastic Recoil Detection

**Author:** Mandla Msimanga<sup>1</sup>

**Co-authors:** Carlos Pineda-Vargas<sup>1</sup>; Craig Comrie<sup>2</sup>; Sean Murray<sup>1</sup>

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Heavy Ion - Elastic Recoil Detection (HI-ERD) analysis is now a well established ion beam technique in the analysis of thin film materials of technological and medical importance. It is to a large extent the most suitable nuclear analytical technique available for simultaneous identification and quantitative depth profiling of light elements in thin films. This presentation describes a Time of Flight (ToF) spectrometer designed and assembled for Heavy Ion - ERD analysis at iThemba LABS and first analysis results thereof.

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## **Planetary wave features and variability of tide at mesosphere/lower thermosphere region**

**Author:** Sibusiso Mthembu<sup>1</sup>

**Co-authors:** R. S Pillay<sup>2</sup>; Sandile Malinga<sup>1</sup>

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Abstract

The activity of planetary waves and variability of tides in the mesosphere/lower thermosphere (MLT) region was studied using the mesospheric wind velocity. Planetary wave activity observed at the MLT region are the result of upward propagating wave which are excited from the lower region of the atmosphere and sometimes are resulting from tidal modulation at planetary wave. Tidal modulation was investigated as the possible candidate for the planetary wave features in the MLT region.

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## **Thermal performance of an oil-pebble/bed thermal energy storage (TES) system for solar cooking**

**Author:** Ashmore Mawire<sup>1</sup>

**Co-author:** Simeon Taole<sup>1</sup>

<sup>1</sup> *North West University, Mafikeng Campus*

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Abstract

Theoretical models of an oil/pebble-bed TES for a solar cooking application are formulated. The experimentally validated models are used to examine the effects of different charging and discharging methods on the thermal performance of the oil/pebble-bed TES system.

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## Optimisation of two volumetric solar receivers that use oil as a heat transfer fluid

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**Co-authors:** Michael McPherson<sup>2</sup>; Robert J Van den Heetkamp<sup>2</sup>; Simeon H. Taole<sup>2</sup>

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Fluent 6.3 software has been used to optimise the designs of two volumetric receivers. The model results indicate that the use of a wire mesh in these receivers does improve their performance. A wire mesh of porosity  $\approx 0.95$  has also been found to be sufficient to improve the efficiency

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## Optimizing the conditions for production of hydrogen using biomass gasification

**Author:** Azwihangwisi Iren Mabuda<sup>1</sup>

<sup>1</sup> University of Fort Hare

Hydrogen is considered as a novel fuel for the twenty first century, mainly due to its environmentally kindly character. Currently, about 90% of the hydrogen is produced by the reactions of natural gas and steam reforming of light oil fractions. These methods mainly consume fossil fuel as energy source, which is not only full with emission problems, but also fossil fuels are depleting at alarming rate. Therefore, there is need to find alternative ways of hydrogen production based on renewable energy sources such as biomass. The main purpose of this project is to optimize the conditions of high production of hydrogen using biomass gasification

330

## Luminescent properties of nanoparticle CaTiO<sub>3</sub> phosphor

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**Co-authors:** H. Swart<sup>2</sup>; J. J. Terblans<sup>2</sup>; Shreyas Pitale<sup>2</sup>

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Praseodymium doped calcium titanate phosphors (CaTiO<sub>3</sub>:Pr) exhibiting red emission are synthesized by using the sol – gel method and the structures were determined using the X-ray diffraction technique. The photoluminescence properties of the CaTiO<sub>3</sub>:Pr were determined using photoluminescence spectroscopy and cathodoluminescence spectroscopy. Particle morphology was determined using Scanning electron microscopy.

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## Electronic and Thermal Transport Properties in the $Ce_xLa_{(1-x)}Ru_2Al_{10}$ system

**Author:** Pararajasingham Peratheepan<sup>1</sup>

**Co-author:** Andre M Strydom<sup>1</sup>

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$Ce_xLa_{(1-x)}Ru_2Al_{10}$  ( $0.6 \leq x \leq 0.99$ ) has been investigated by means of electrical resistivity, thermal conductivity and thermopower. Temperature dependence of electrical resistivity reveals metal-insulator transition that shifts systematically towards low temperatures with increasing La concentration. Fairly small thermal conductivity and enhanced thermopower are observed for  $x = 0.95$  and  $0.99$ .

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## Experimental performance of three solar receivers that use oil as a heat transfer fluid

**Author:** JUSTICE S.P MLATHO<sup>1</sup>

**Co-authors:** Michael McPherson<sup>2</sup>; Robert J Van den Heetkamp<sup>2</sup>; Simeon H. Taole<sup>2</sup>

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A Conical Tube (CT) and two volumetric solar receivers have been designed. The volumetric receivers have maximum efficiencies of 35 % for outlet temperatures ( $T_{out}$ ) of 100 °C while that of the CT receiver is 42 %. Thus the CT receiver has best designed.

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## The Development of a Novel Heliostat System for Experimentation and Testing

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To perform test on solar energy components and subsystems, a heliostat with louvered mirror-panels mounted on a turntable has been constructed. This paper discusses the development of the control system to direct the reflected radiation to the laboratory hut in which the systems under test are placed.

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## WIRELESS POWER TRANSMISSION FOR WIRELESS SENSOR NETWORKS

**Author:** Agboola Teru<sup>1</sup>

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Many wireless sensors are getting smaller due to new solid-state devices, increased precision in fabrication and compact layout techniques. Wireless Sensors have been in use for sometime in different applications. Some of these sensors rely on batteries to power them. This makes it cumbersome if a number of them need to be used in some instances with varying distances. These sensors can be made to operate in the presence of microwave field. Microwave wireless power transmission (WPT) is a promising technique for the long-term power supply for small devices such as wireless sensor network (WSN) devices. The primary components include a m

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## Femtosecond Laser Induced Breakdown Spectroscopy applied to depth profiling of 500-micron ZrO<sub>2</sub> spheres

**Authors:** Anton du Plessis<sup>1</sup>; Ted Roberts<sup>1</sup>

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Femtosecond Laser Induced Breakdown Spectroscopy (femto-LIBS) was applied to a depth profiling problem in 500-micron diameter spheres of ZrO<sub>2</sub>. The spheres were provided containing silver inside, and in addition they were coated with a thin layer of silver on the surface for this study. This is a feasibility study for diagnosing leakage of radioactive silver through the silicon carbide barrier of fuel particles for a high temperature gas reactor.

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## Femtosecond laser control of the chemical reaction of carbon monoxide and hydrogen

**Author:** Anton du Plessis<sup>1</sup>

<sup>1</sup> *CSIR National Laser Centre*

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Femtosecond laser control of the chemical reaction of CO and H<sub>2</sub> is studied. Specific high-value reaction products can possibly be produced selectively, without need for further separation or purification. In this work, we aim at controlling the reaction between CO and H<sub>2</sub> to produce hydrocarbon products, of interest to the petrochemicals industry. Preliminary experimental results will be presented.

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## Phootball Physics: The Science of Soccer!

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With the World Cup Soccer the biggest talking point of this year, how can we use it to popularise Physics? This show, developed for Sci-Bono Science Centre in Johannesburg, does just that. Investigating the design of the new “Jabulani” soccer ball, how Beckham manages to “bend it” and why peripheral vision is important for passing, it suggests exciting ways to present practical Physics. The Science of Soccer exhibits developed alongside the show will also be presented and evaluated. The presenter has been popularising Physics with exciting shows for over 20 years and will share his experiences.

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## Seismic waves in the atmospheres of A stars

**Author:** Rodney Medupe<sup>1</sup>

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We discuss the physics of p-modes travelling through the atmospheres of A stars. We show how the fluctuations in opacity affects the perturbations in flux and discuss the new formulae we derived that relates the flux perturbations to temperature and opacity perturbations. Our new formula is compared with other formulae that have been used in the studies of the p-modes

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## Mode-identification using multiphotometric data

**Author:** Rodney Medupe<sup>1</sup>

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Medupe et al (2009) presented a new formula for calculating perturbation in flux as a function of wavelength and mode. They suggested that such a formula will be suitable for mode-identification and will be better than currently used formulae because it takes into consideration the shapes of the eigenfunctions in the atmospheres of A stars, and does not depend on many parameters. In this poster we compare the new formula with multicolor photometric data and see how it compares with existing formula.

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## Mode-identification using multi-colour photometric data of beta Cephei stars

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beta Cephei stars are hot massive B stars that pulsate with periods of between 1.6 and 7.7 hours. They oscillate because of seismic waves that travel through these stars. Seismic waves have been used to infer interior conditions and properties of stars. In order for this technique to be used successively, the pulsation modes need to be identified. In this poster we present a mode-identification technique that compares theory with CCD photometric data obtained on the 30inch telescope at Sutherland SAAO observing station.

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## Effects of target resonances in Multi-Channel Algebraic Scattering

**Author:** Steven Karataglidis<sup>1</sup>

**Co-authors:** Dirk van der Knijff<sup>2</sup>; Juris Svenne<sup>3</sup>; Ken Amos<sup>2</sup>; Luciano Canton<sup>4</sup>; Paul Fraser<sup>5</sup>

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Low-energy nucleon-nucleus elastic scattering involving particle-unbound states in the target spectrum is developed within the framework of a Multi-Channel Algebraic Scattering theory. The effects on the scattering observables when the particle-emission widths are significantly different from zero are discussed.

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## Effective Interaction of Bosons and Fermions in the Non-Commutative Plane

**Author:** Andreas Hafver<sup>1</sup>

**Co-author:** Frederik Scholtz<sup>2</sup>

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In non-commutative quantum mechanics position space becomes fuzzy. This has implications for the way particles interact. We show that the effective interaction between fermions and bosons is modified, leading to an apparent violation of Pauli's exclusion principle.



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## General Relativistic considerations for Space Geodesy

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The accuracy of Space Geodesy techniques have improved to such an extent that routine data analyses need to incorporate the effects of General Relativity Theory (GRT). A comparison between the accelerations perturbing the orbits of the two LAGEOS satellites resulting from GRT and other non-GRT accelerations are made. The analyses of the resulting data have to be done within the framework of a post-Newtonian formalism.

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## A CdO Based LPG gas Sensor

**Author:** Amanda Sefage<sup>1</sup>

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A CdO based LPG gas sensor has been fabricated from the deposition of CdO thin film on a glass substrate by PLD and Sputtering deposition techniques. The structural, morphological, chemical compositional analysis and gas sensing properties of the CdO thin films is still needed to be characterized by using SEM, XRD, RBS and UV-VIS Spectrometry, etc. The electrical resistance and gas response of the LPG gas sensor was investigated at different operating temperatures and different gas concentrations.

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## OPTIMISATION OF LASER HARDENING PARAMETERS FOR TURBINE BLADE STEELS

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A 4.4 kW Sinar continuous wave Nd: YAG solid-state laser was used for laser hardening of turbine blade steel (chemical composition: 0.19%C; 0.32%Si; 0.38%Mn; 0.01%P; 0.002%S, 12.72%Cr, 0.41%Ni). The laser processing parameter i.e. scan speed and laser power were varied while the temperature was held constant 1050°C. The characterisation of the hardened surfaces was carried out by Optical Microscopy (OPM), Scanning Electron Microscopy (SEM/EDS) and X-ray Diffraction (XRD). Hardness measurements were carried out, a through-thickness hardness profile (indentations from the surface of the alloyed layer through to the base) was determined with a 1

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## Laser Surface Alloying (LSA) of Martensitic Stainless Steel using Nickel Powder

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<sup>1</sup> *Tshwane University of Technology*

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The current investigation deals with laser surface alloying of nickel powder on martensitic stainless steel, the aim was to improve the hardness of the substrate. Nd-YAG laser was used with argon as shielding gas and process parameters were varied. The characterization of the alloyed surface was carried out by Optical Microscopy (OPM), Scanning Electron Microscopy (SEM/EDS) and X-ray Diffraction (XRD). The microstructure of alloyed layer shows the nickel powder was well dispersed within the metal matrix. Hardness measures were carried out. The average hardness values for the alloyed layers were calculated. A significant increase in the hard

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## HARDNESS AND MICROSTRUCTURE OF X12CrNiMo MARTENSITIC STAINLESS STEEL LASER ALLOYED WITH TITANIUM CARBIDE

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X12CrNiMo martensitic stainless steel was laser alloyed with Titanium Carbide using a 4.4 kW CW Nd-YAG laser. The microstructure of the MMC was investigated using optical microscopy, X-ray diffraction (XRD) meter and scanning electron microscopy (SEM). A Vickers's hardness profile-indentations from the surface of the alloyed zone through to the substrate was measured at 100 µm interval using a load of 200 g. The alloyed Zone reveal a pores and cracks free MSS-TiC MMC. When the laser power and scanning speed were 2 kW and 0.014 m/min respectively, a Vickers's hardness value of two times that of the substrate was achieved in the MMC.

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## Interface energy of multiband superconductors

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**Co-authors:** Joerg Schmalian<sup>2</sup>; Rafael Fernandes<sup>2</sup>; Vladimir Kogan<sup>2</sup>

<sup>1</sup> *NITheP, University of Stellenbosch*

<sup>2</sup> *Ames Laboratory, University of Iowa State*

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Using Ginzburg-Landau theory of two band superconductors, we determine the surface energy between coexisting normal and superconducting solutions at the thermodynamic

critical field. Close to the transition temperature,  $T_c$ , the two band problem maps onto an effective single band problem. While the order parameters of the two bands may have different amplitudes in the homogeneous bulk, near the critical temperature the Josephson coupling between the bands leads to the same spatial dependence of both order parameters near an interface or a vortex. This finding puts into question the possibility of Type 1.5 superconductivity, at least near  $T_c$ .

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## **Thermal characterization of various biomass materials for co-gasification with coal**

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Investigations into the gasification behavior during co-gasification of coal, biomass materials and coal/biomass blends prepared at different ratios (10:90, 20:80, 30:70, 40:60, and 50:50) have been conducted using a Thermogravimetric analysis (TGA) apparatus. Biomasses (pine wood, eucalyptus and cow dung) and coal (bituminous and lignite) were used. Devolatilization behavior of different coals and biomasses under heating conditions used (20 °C/min and high N<sub>2</sub> flow rate) typical of pyrolysis were investigated for kinetic parameter determination. Simulations were also done for material characterization.

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## **SHORT-PULSE GENERATION IN A DIODE END PUMPED SOLID STATE LASER**

**Author:** Sandile Ngcobo<sup>1</sup>

**Co-authors:** Christoph Bollig<sup>1</sup>; Hurbetus von Bergmann<sup>2</sup>

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A Nd:YVO<sub>4</sub> modelocked laser has been constructed using a resonator designed according to the theoretical parameters. The laser produced pulses in the picosecond region with a maximum average output power of 2.8W. Passive modelocking of the Nd:YVO<sub>4</sub> laser has been demonstrated using a semiconductor saturable absorber mirror (SESAM).

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## **Design and construction of spray pyrolysis deposition unit for the synthesis of spectrally selective thin solid films**

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The fabrication of thin solid films was conducted using spray pyrolysis technique where the source solution (Organometallic : Grignard Reagent) was dissolved in diethyl ether and inorganic salts) was sprayed in compressed air for 15 minutes then stop to the heated glass substrate and temperature ranges from 290 oC to 350 oC at the deposition chamber.

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## **Aspects of DC circuits: a fine grained investigation of student conceptions**

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Little is known about how fine-grained contextual changes impact student reasoning in the context of DC circuits. We report on a study using an open circuit (battery, single wire, resistive element) in which the resistive element (resistor, heating element, light bulb) and the words (“current”, “charge flow”) are inter-changed.

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## **Photometric Analysis of Beta Cephei Type Star ”BW Vul”**

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**Co-author:** Can Akan<sup>2</sup>

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In this work; the U, B and V light curves of a  $\beta$  Cephei type variable BW Vulpeculae (BW Vul, HD 199140, B2 III) obtained with photometric observations. Besides obtaining the U, B and V light curves for this star, maxima times were obtained as well. Not only the data have been analysed but also the pulsation mode of BW Vul has been identified by Watson (1988) Method.

As a result of these analyses, it's been concluded that BW Vul is pulsating with radial single mode and BW Vul is a member of a binary system.

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## **INVESTIGATION OF LUMINESCENCE PROPERTIES OF TERBIUM DOPED Mg<sub>2</sub>SiO<sub>4</sub> DOSIMETERIC MATERIAL**

**Author:** Timuçin Gülmez<sup>1</sup>

**Co-authors:** Elçin Ekdal<sup>2</sup>; Turgay Karalı<sup>2</sup>

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Dosimetric characteristics of thermoluminescence(TL) material principally depend on kinetic parameters describing the TL mechanism in the phosphor. Therefore, any reliable dosimetric study of new thermoluminescent materials should include the determination of kinetic parameters, order of kinetics  $b$ , activation energy  $E$  and frequency factor  $s$ . In this study, kinetic parameters of  $Mg_2SiO_4:Tb$  dosimeter have been analyzed in terms of TL and also effect of photo-transferred TL (PTTL) has been investigated via various light sources

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## **Interface properties of O<sub>2</sub> annealed Au/Ni/n-AlGa<sub>N</sub> and Ir/n-AlGa<sub>N</sub> Schottky barrier systems**

**Author:** Matshisa Legodi<sup>1</sup>

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We systematically annealed Ni/Au and Ir Schottky contacts on Al<sub>0.35</sub>Ga<sub>0.65</sub>N in O<sub>2</sub>. Our Capacitance-Voltage-Frequency (C-V-f) measurements reveal the presence of anomalous peaks at 0.9V for Au/Ni/Al<sub>0.35</sub>Ga<sub>0.65</sub>N and at 0.8V and 1.2V for the Ir/Al<sub>0.35</sub>Ga<sub>0.65</sub>N contact system. The overall quality of both Schottky systems improves with O<sub>2</sub> annealing up to 573K.

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## **Development of a software to package for the design and calculation of Research Reactors using Monte Carlo and Analytical Methods**

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There is a global drive to build new research reactors, currently the calculation of various safety and performance parameters is very time consuming for a single design. In the calculation process there are two classes of solutions, Monte Carlo methods which are accurate and flexible but slow and analytical methods which are very fast but not as accurate or flexible. This paper will look at creating a hybrid solution between MCNP (Monte Carlo) and OSCAR (analytical) as well as create input sets for both code systems using AI, this will take months to do without a code system. The code system will be easy to use and aid in reactor calculation

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## **Guided acoustic modes and elastic moduli of ZnO nanorods**

**Author:** Bhekumusa Mathe<sup>1</sup>

**Co-authors:** Darrell John Comins<sup>1</sup>; Deena Naidoo<sup>1</sup>

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Elastic and stiffness moduli of vertically aligned single-crystal ZnO nanorods grown on Si(001) substrates were determined quantitatively by the surface Brillouin scattering technique. A longitudinal guided mode at 16 – 18 GHz enabled the exact determination of  $c_{11}$  from which  $c_{11}$  and  $c_{44}$  were measured to be 116 GPa and 42.4 GPa respectively, at room temperature.

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## Physics learning: F for Fail or F for Feat?

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F for “fail” or “feat”? The “system” of learning Physical Science in South Africa keeps on getting an F for “fail” in spite of various efforts to improving it. Examples will be provided of this failure and some suggestions discussed on the possible achievement of an F for “feat”.

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## Lightning Atmospheric count rate from Marion Island

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The lightning spheric count rate from the VLF receiver at Marion Island is presented. Time variation on short to long scales is investigated, and modeled in terms of lightning activity in the southern hemisphere, taking into account propagation conditions over land, ocean and ice.

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## Oxidation of PtSb<sub>2</sub> using ab-initio techniques

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Studies of low index surfaces of PtSb<sub>2</sub> have been carried out using the Density Functional theory to oxidize them and find the stability profiles. Indications are there that the oxygen atom (O) and molecules (O<sub>2</sub>) prefers to bind with the antimony rather than the platinum atom.

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## Stabilities of low and high pressure structures of FePO<sub>4</sub>

**Author:** NDANDULENI LESLEY LETHOLE<sup>1</sup>

**Co-author:** Phuti Esrom Ngoepe<sup>2</sup>

<sup>1</sup> SAIP

<sup>2</sup> material modeling center

On introducing amorphisation recrystallisation methods to LiFePO<sub>4</sub>, ternaries (FePO<sub>4</sub>), will be more amenable than the quaternary LiFePO<sub>4</sub>, since they are less complex. Hence we investigate the stabilities of the different polymorphs of FePO<sub>4</sub>, before atomistic simulations, by employing the pseudo-potential planewave calculations within the Local Density Approximation (LDA) and parfew-wang Generalized Gradient Approximation (GGA).

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## IAU Office for Astronomy Development

**Author:** Kevindran Govender<sup>1</sup>

<sup>1</sup> South African Astronomical Observatory

This non-specialist presentation will discuss South Africa's recent selection as host of the prestigious Office for Astronomy Development, an initiative of the International Astronomical Union (IAU). This office aims to realise the IAU's decadal strategy to take astronomy to the developing world.

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## THE EFFECTS OF RADIATION ON PLATINUM BASED ALLOYS AND COATINGS.

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**Co-author:** Mira Topic<sup>2</sup>

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The study of radiation effects on platinum binary systems has both the fundamental and applied aspects. It is due to the fact that the formation of ordered domains with the super-lattice structure increases the strength and surface hardness and could also have an impact on surface activity and

chemical properties. The changes of mechanical, physical and chemical properties caused by radiation could be of significant importance for application of platinum systems as catalysis, gas sensors, fuel cells and biomedical and nuclear engineering applications. Therefore, various aspects of radiation effects on platinum systems are addressed in this research.

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## ADOPTING AUTOFLUORESCENCE SPECTROSCOPY IN THE DIAGNOSIS OF HUMAN BREAST AND COLORECTAL CANCERS

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Fluorescence spectroscopy is an evolving technology that can rapidly differentiate between non neoplastic and malignant tissues. These differences are thought to be due to endogenous fluorophores. This technique is a non-invasive diagnostic tool that can identify diseased tissue sites in vitro and in real time. It could have a major impact on the detection and treatment of cancer. The current study evaluates the utility of autofluorescence spectroscopy to distinguish tissue transformation associated with the malignant change in two types of human cancer, namely breast and colorectal cancer.

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## PHYSICS FRESHMEN – DIFFICULT TO CHANGE

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New students prefer to be taught through being given formulae, memorizing definitions and working through memorandums of previous question papers. They show arrogant attitude when they are not taught differently, such as in Interactive Inquiry Learning manner. They improve their attitude only when the confronting experiments give plausible answers. This is a conceptual change: accommodation.

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## From Para/Helimagnetic to Ferromagnetic Transition of Pulsed Laser Deposited Fe<sub>1-x</sub>CoxSi Thin Films

**Authors:** Balla Ngom<sup>1</sup>; Ncholu Manyala<sup>2</sup>

**Co-authors:** Aboubaker Beye<sup>1</sup>; Alan Johnson<sup>3</sup>; Andre Strydom<sup>4</sup>; Andrew Forbes<sup>5</sup>; John DiTusa<sup>6</sup>; Malik Maaza<sup>7</sup>; Remy Bucher<sup>7</sup>

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We report pulsed laser deposition synthesis and characterization of polycrystalline Fe<sub>1-x</sub>CoxSi thin films on Si (111). Ferromagnetism with significant magnetic hysteresis is found for all films including nominally pure FeSi which reveals transition from paramagnetic and helimagnetic to ferromagnetic for Fe<sub>1-x</sub>CoxSi for FeSi and Co doped FeSi.

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## **Biological Shield Design for a 20 MW Materials Testing Reactor**

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**Co-author:** Johann Van Rooyen<sup>1</sup>

<sup>1</sup> *NECSA*

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In this study we focus on the biological shielding around a 20 MW Oak-Ridge type Materials Testing Reactor. The design of the biological shielding around this type of research reactor was performed at ORNL in the USA in the late 1950s and early 1960s, i.e. in the days before powerful digital computers, powerful codes or accurate cross-section data were available. We investigate several shielding materials and propose an optimal shield design. This proposed design is compared with the existing shield.

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## **Nanostructuring diamond surfaces using highly charged ions**

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The nanostructuring of diamond and graphite surfaces using highly charged ions is studied. Results are presented in terms of changes in morphology and local electronic states observed using atomic force microscopy (AFM) and scanning and tunnelling microscopy (STM) respectively. Energy dependence of defect formation coupled with the use of advanced nanostructuring facilities such as the electron beam ion trap (EBIT) allow the rare opportunity of fabricating scalable solid state quantum information devices and other devices that have been structured on the nanoscale.

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## **Determination of neutron energy spectra inside a water phantom irradiated by neutrons of energy up to ~ 64 MeV.**

**Author:** Mark Herbert<sup>1</sup>

**Co-authors:** Andy Buffler<sup>2</sup>; Frank Brooks<sup>2</sup>; Rudolph Nchodu<sup>2</sup>; Saalih Allie<sup>2</sup>

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A neutron spectrometer based on NE230 deuterated liquid scintillator was developed to measure neutron energy spectra in water. Neutron energy spectra were obtained from measurements of pulse height spectra using the Bayesian unfolding code MAXED. Results from measurements made along the beam-axis compare well with Monte Carlo calculations using MCNPX.

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## INFLUENCE OF LOW INTENSITY LASER IRRADIATION (LILI) ON GLOBAL METHYLATION OF THE DNA IN CANCER CELLS

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**Abstract:** Since cancer is a result of erroneous regulation of genes, we investigated whether low intensity laser irradiation has an influence on the epigenetic state, specifically global methylation, of the DNA in five different cancer cell lines in vitro. Possible consequences may include changes in gene expression and DNA conformation.

### 1. Introduction

Photodynamic therapy (PDT) for cancer is a treatment where low intensity light irradiation (LILI) activates a drug that has accumulated in the tumour resulting in cell death (1). LILI itself has an influence on cell metabolism and viability (2), suggesting that the regulation of gene expression

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## Novel polymer - attached Nitrogen - doped Carbon nanotube solar cells

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A novel photovoltaic device employing poly-3-hexylthiophene attached N-CNTs as active layer, giving Voc > 0.3V and Jsc ~ 1 mA/cm<sup>2</sup>, at 100 mW/cm<sup>2</sup> white light illumination is presented. The polymer attached N-CNTs were produced by polymerizing 3-hexylthiophene using FeCl<sub>3</sub> catalyst

in the presence of functionalized N-CNTs that had been synthesized by the floating catalyst CVD method.

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## Novel electronic properties of nanodiamond films

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**Co-authors:** D Churochkin <sup>1</sup>; K V Shah <sup>1</sup>; S Bhattacharyya <sup>1</sup>; Z Chiguvare <sup>1</sup>

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Nanocrystalline diamond films were synthesized by chemical vapor deposition and characterized to explore their potential device applications. Electrical conductivity measurements at low temperatures and high magnetic fields showed weakly localized transport in three dimensions in ultranancrystalline diamond films. Also a semi-classical model is developed to explain their unusual magneto-resistance properties.

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## The Recent Developments of Quantum-secured Communication in Durban

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The Centre for Quantum Technology has recently secured the link between the Moses Mabhida Soccer Stadium in Durban with the Joint Operations Centre (JOC) of the province using quantum based encryption systems. The link was used by the eThekweni Municipality during the 2010 FIFA World Cup to encrypt all communication between the stadium and the JOC. This, being the first ever public global event using quantum communication, marks a major milestone in the commercial acceptance of this technology. We present our results and experiences of this project.

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## Resonant tunneling in n-doped multi-layered carbon systems

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A tight-binding model of carbon superlattice structures with randomly distributed hopping parameters is developed to interpret the effective nitrogen doping effect on large transmission coefficients of electrons. The calculated current density explains successfully the device characteristics of

multilayered carbon including layered graphene structures at low temperatures and high magnetic fields.

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## High field magneto-transport of metal-filled carbon nanotubes

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Synthesis of thin multi-walled carbon nanotubes uniformly filled with over 40% of iron is reported. Magneto-resistance measurements of these novel nano-materials at low temperatures over a wide range of magnetic field, up to 12 Tesla establish one-dimensional behavior and show their potentials for novel spintronic device applications.

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## Transport properties of multilayered graphene and related carbon systems

**Author:** Messai Mamo<sup>1</sup>

**Co-authors:** Christopher Coleman <sup>1</sup>; Neil Coville <sup>1</sup>; Ross McIntosh <sup>1</sup>; Rudolph Erasmus <sup>1</sup>; Somnath Bhattacharyya <sup>1</sup>

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Graphene layers were synthesized chemically and characterized systematically by spectroscopic and microscopic techniques. We study electron transport in these materials at low temperatures as well as at high magnetic fields and compare with device properties of multi-layered carbon films to show their potential in sensor device applications.

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## On the sign of population lensing effect in Chromium-doped materials

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**Co-authors:** Kamel Ait-Ameur <sup>2</sup>; Michael Fromager <sup>2</sup>; Richard Moncorgé <sup>2</sup>; Tomaz Catunda <sup>3</sup>

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We report measurements of polarisability changes  $\Delta\alpha$  between the excited and ground states of the chromium active ions in a laser material by using two different methods (time-resolved divergence diagnostic, Z-scan techniques). The first one indicates that  $\Delta\alpha < 0$  (converging population lensing), while the second one gives  $\Delta\alpha > 0$  (diverging population lensing). This discrepancy has been resolved by introducing the concept of correlation collapse between the centre and the wings of a laser beam subject to intra-cavity clipping.

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## **Phototoxic effect of Zinc sulfophthalocyanine photosensitizer on human (DLD-1) and lung (A549) carcinoma cells (in vitro).**

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Abstract: Photodynamic therapy (PDT) is a minimally invasive therapeutic modality for different cancers. The aim of this study was to determine the phototoxic pattern of Zinc sulfophthalocyanine (ZnPcSmix) photosensitizer in DLD-1 and A549 cells and the extent of PDT using different concentrations of photosensitizer.

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## **Lasers in Nuclear Physics: Nuclear Structure by Laser Spectroscopy**

**Author:** Sergey Zemlyanoy<sup>1</sup>**Co-authors:** Boris Markov <sup>1</sup>; Dimitry Karaivanov <sup>1</sup>; Krassimira Marinova <sup>1</sup>; Yuri Gangrsky <sup>1</sup><sup>1</sup> Joint Institute for Nuclear Research**Corresponding Author:** zemlya@jinr.ru

Studies of hyperfine structure and isotope shifts form a bridge between nuclear and atomic physics and serve as a tool for investigation of nuclear properties and basic physical principles. This work presents some recent results on investigation of nuclear shape and size of rare earth isotopes by laser spectroscopy methods at JINR, Dubna.

381

## **A Rough Guide to Nanomagnetism**

**Author:** David Dekadjevi<sup>1</sup><sup>1</sup> University of Johannesburg

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The information revolution, which has modified our way of living over the last few decades, has occurred due to the restless exponential growth of information amount that can be processed, stored, and transferred per unit time and unit area of relevant devices. Nanomagnetism is becoming a very important research area in past decades due to its keyrole in this revolution. The main goal of Nanomagnetism is to gain knowledge on spin-dependent phenomena, and to exploit them for new functionalities. This talk will present a review of some of the current developments of nanomagnetism and expose some of the future trends.

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## **Polarization Encoded QKD in Fibre**

**Author:** Sharmini Pillay<sup>1</sup>

**Co-authors:** Abdul Mirza<sup>1</sup>; Francesco Petruccione<sup>1</sup>

<sup>1</sup> *University of KwaZulu-Natal*

QKD uses quantum mechanics to ensure a secure line of communication between two parties. The implementation of QKD using the BB84 protocol in fibre optic cables is a challenge due to birefringence. However this can now be compensated for in a fibre optic cable, thus allowing polarization encoded QKD in fibre.

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## **SKA Site Comparison Using Satellite Weather Data**

**Authors:** Isobel Kolbe<sup>1</sup>; Michael Gaylard<sup>2</sup>

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Monthly averaged weather parameters for day and night from satellite infrared and microwave data for the areas containing the proposed Square Kilometre Array (SKA) radio telescope core sites in Australia and South Africa are compared.

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## **Ab-initio modeling of non-stoichiometric FeO<sub>1-x</sub>S<sub>x</sub> using the VCA approach**

**Author:** Masilu Godfrey Mulaudzi<sup>1</sup>

**Co-author:** Lutz Ackermann<sup>1</sup>

<sup>1</sup> *Materials Modelling Center - University of Limpopo*

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We present an ab-initio study of non-stoichiometric mixed iron oxide / sulfide using the virtual crystal approximation (VCA). This allows us to analyse the cell parameter, the bulk modulus and the density of states as a function of sulfur content.

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## Nonequilibrium thermal entanglement for three spin system

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**Co-authors:** Francesco Petruccione <sup>1</sup>; Nathan Pumulo <sup>1</sup>

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The dynamics of a simple spin chain (three spins) coupled to bosonic baths at different temperatures is studied. The dynamics and temperature dependence of spin-spin entanglement is analyzed. Special attention is given to the entanglement in the stationary state of the system.

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## The (un)preparedness of learners for FET mechanics

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Two questionnaires were administered to probe learners' preparedness for learning mechanics in Grades 10-12. Firstly the knowledge that 1211 Grade 10 learners acquired in the theme Energy and Change in the previous school phase was determined. A second investigation probed 122 Grade 9 learners' primordial conceptions regarding motion. The results indicated fragmented, incoherent cognitive structures with reliance on observational rather than scientific explanations. Both the investigations showed deficiencies for effective elaboration of learners' knowledge in mechanics.

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## The cognitive refinement model for learning physics

**Authors:** Miriam Lemmer<sup>1</sup>; Nico Lemmer<sup>1</sup>

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Alternative conceptions are a perennial problem in physics education. The problem can be approached from different historically predominant theoretical frameworks, e.g. the empirist-behaviorist and constructivist frameworks. A hypothesis of the learning process in physics is proposed, termed the cognitive refinement model. It identifies three levels of learning, viz. perceptual, conceptual and formal. Its implications for the physics curriculum are discussed with illustrative examples emanating from physics education research.

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## Internal and External Oxidation Products on Ni-Based Superalloy TMS-75

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Ni-based superalloy TMS-75 was oxidized at 900°C in air. SEM, TEM and Raman Spectroscopy were used to characterize reaction products. At this temperature, an external non-protective (Ni,Co)O scale plus an extensive internal reaction zone consisting of oxide and nitride phases are formed. Orientation relationships were found between the oxide phases.

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## Mr

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The dynamics of single photon wave packets interacting with beam splitters, mirrors and interferometers is investigated. In the simulation the beam splitters are microscopically as arrays of two level atoms. The non-trivial simulations will be using Modern Graphics Processing Units (GPUs). These devices offer tremendous potential for performance and efficiency.

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## Doppler-Free Saturation Spectroscopy

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**Co-authors:** Francesco Petruccione<sup>2</sup>; Magnus Rehn<sup>2</sup>

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Laser cooling and trapping of atoms have become a significant area of research in physics. Saturation absorption spectroscopy is an important element in the laser cooling setup. We have investigated methods to improve the technique of saturation spectroscopy resulting in resolving hyperfine transitions of rubidium atoms which are concealed by Doppler broadening.

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## CN2 profiles from a turbulence-resolving model

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Optical turbulence, occurring mostly in the planetary boundary layer (PBL), degrades geodetic data. Site characterisation requires knowledge of the vertical distribution of optical turbulence, the CN2 profile. A CN2 profile, obtained by employing a database of turbulence-resolving simulations, is compared with an observational profile.

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## Security of Quantum Cryptography Protocols-Novelty and Realizations

**Author:** Mhlambululi Mafu<sup>1</sup>

**Co-authors:** Abdul Mirza<sup>1</sup>; Adriana Marais<sup>1</sup>; Francesco Petruccione<sup>1</sup>

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Protocols for quantum communication, particularly for quantum cryptography are considered. The general theory of privacy in quantum communication will be investigated. Definition, analysis and validation of the security of quantum cryptographic protocols, support the realization of a secure and reliable quantum communication channel between two distant parties

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## Ab-initio structural and mechanical stability study of the uranium – aluminium alloys (UA12, UA13 and UA14)

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We use DFT calculations within GGA-PBE approximation to investigate the structural and mechanical stability of uranium-aluminium systems. Our results provided excellent heats of formation and predict UA12 to be more stable, in agreement with experiment. Phonon dispersion spectra confirmed relative structural trend, all three compounds where mechanical stability

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## Ultracold atoms in the Quantum Research group at UKZN

**Author:** Magnus Rehn<sup>1</sup>

**Co-authors:** Francesco Petruccione<sup>1</sup>; Malehohonolo Semonyo<sup>1</sup>

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We report on the latest experimental achievements with ultracold atoms in the Quantum Research group at UKZN. As previously reported, we have cooled a dilute gas of Rubidium atoms to mikroKelvins in the first Magneto Optical Trap in Africa. Currently we are implementing methods for better diagnostics as well as transfer to of cold atoms between different vacuum chambers. Some of the long term goals of Quantum Information processing with Ultracold Atoms will also be mentioned.

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## Optical properties of metal nanoparticles formed by ion implantation in oxides

**Author:** Anna Kozakiewicz<sup>1</sup>

**Co-author:** Trevor Derry<sup>2</sup>

<sup>1</sup> Wits

<sup>2</sup> Wits, School of Physics

Abstract: Ion implantation was used to produce nanostructures in MgO, Al<sub>2</sub>O<sub>3</sub> and SiO<sub>2</sub>. Optical absorption spectra show surface plasmon resonance bands characteristic of the implanted metal ions. Upon annealing in reducing atmospheres the optical response of metal nanostructures changes what is related directly to their morphology, shape and size.

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## Interaction of diamond (1x1) and (2x1) reconstructed (111) surfaces with oxygen: A density functional theory study (DFT)

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The properties of oxygen atoms on C(111)-(1x1) and the (2x1) reconstructed surfaces have been investigated using DFT. The on-top site is preferred by oxygen atoms on the (1x1) surface, while the bridge site is favourable on the (2x1) reconstructed surface. Other properties like stability and workfunction are also reported.

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## **Intra-cavity generation of Bessel-like beams with longitudinally dependent cone angles**

**Author:** Igor Litvin<sup>1</sup>

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We report on two resonator systems for producing Bessel-like beams with longitudinally dependent cone angles (LDBLBs). Such beams have extended propagation distances as compared to conventional Bessel-Gauss beams, with a far field pattern that is also Bessel-like in structure (i.e. not an annular ring). The first resonator system is based on a lens doublet with spherical aberration, while the second resonator system makes use of intra-cavity axicons and lens. In both cases we show that the LDBLB is the lowest loss fundamental mode of the cavity, and show theoretically the extended propagation distance expected from such beams.

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## **THE EFFECT OF SILICON CARBIDE CRYSTAL STRUCTURE TRANSFORMATION ON GASEOUS FISSION PRODUCT RELEASE FROM THE TRISO COATED PARTICLE OF THE PEBBLE BED MODULAR REACTOR'S FUEL PEBBLE**

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The effectiveness of silicon carbide (SiC) to act as a barrier to migration of gaseous fission products (FP) through the (Tri-Isotropic) TRISO coated particle out of the fuel pebble depends on its ability to maintain its crystal structure. However, analyses of irradiated fuel pebbles indicate that the crystal structure of the SiC is greatly affected by the duration of irradiation, irradiation temperature and the neutron flux of the reactor causing the crystal structure to undergo structural changes (amorphisation), changing from  $\alpha$ -SiC to  $\beta$ -SiC. The diffusion of fission products through the SiC layer of the TRISO coated has been found to follo

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