

DEPARTMENT OF PHYSICS & ASTRONOMY  
*College of Science*



**24<sup>th</sup> DEPARTMENTAL CONFERENCE**

Monday 3<sup>rd</sup> and Tuesday 4<sup>th</sup> September 2007  
MATH031



**Venus and the Moon**

# Programme

**Monday 3 September****10:00 – 10:25 MORNING REFRESHMENTS - MATH101**

<b>Session 1</b>	<b>Chairperson:</b>	<b>Michael Albrow</b>
	<i>Welcome</i>	<b>Roger Reeves</b>
10:30 – 10:45	Anas Sedayo	<b>Improve the contrast of angiogram image by using the Medipix detector based on Monte Carlo simulation.</b>
10:45 – 11:00	Greg Betzel	<b>Synthetic Diamonds for Radiation Therapy Dosimetry</b>
11:00 – 11:15	Suruj Suenarine	<b>Calibrating IceCube PMTs in ice: Parameterization of PMT non-linear response</b>
11:15 – 11:30	Veronica Miller	<b>Phase Dispersion Minimisation as a Period Determination Technique in Extra-Solar Planetary Transit Searches</b>
11:30 – 11:45	Martin Henseler	<b>The Optoelectronic Structure of Bulk ZnO</b>
11:45 – 12:00	Judy Mohr	<b>Atmospheric Turbulence Profiling at MJUO</b>
12:00 – 12:15	Adam Gillard	<b>Deriving The Veltman Propagator From <math>(1/2, 1/2)</math> Representation Space.</b>
12:15 – 12:30	David Mackenzie	<b>Making clusters with Ge ingredients.</b>

**12:30 – 1:30 LUNCH -**

<b>Session 2</b>	<b>Chairperson</b>	<b>Veronica Miller</b>
1:30 – 1:45	James Flewellen	<b>Development of clinically-viable applications of MR elastography</b>
1:45 – 2:00	CaseyTee	<b>Copper nanoscale cluster deposition technology for ULSI interconnects</b>
2:00 – 2:15	Siramas Komonjinda	<b>An analysis of GT Muscae - a quadruple system with an active binary star</b>
2:15 – 2:30	Lou Reinisch	<b>Optical Fluorescence background in Optical Fibre Scintillator Dosimeters</b>
2:30 – 2:45	Niels Gresnigt	<b>The Casimir operators of the Stabilized Poincare-Heisenberg algebra</b>
2.45 – 3.00	Ahmad Ayesh	<b>Nanocluster devices</b>

**3:00 – 3:30****AFTERNOON REFRESHMENTS MATH101**

<b>Session 3</b>	<b>Chairperson:</b>	<b>David Mackenzie</b>
3.30 – 3.45	Ruth Peszynski	<b>National Radiation Oncology Dose Audit</b>
3.45 – 4.00	Paul Miller	<b>The optical characterisation of zinc oxide.</b>
4:00 – 4.15	Ewan Orr	<b>Experiments with Graphical Sex</b>
4.15 – 4.30	Mita Gopal	<b>High Resolution Spectral Models for Globular Clusters: Construction of the Models and Application to Local Group Globular Clusters</b>
4.30 – 4.45	Kathleen Monahan	<b>Atmospheric mixing at the boundary between the stratosphere and troposphere</b>
4.45 – 5:00	Giles Reid	<b>Long Range Neutrino Effects</b>
4.45 – 5.00	Ben Leith	<b>Multi-scalar black holes</b>

**END OF DAY ONE****Tuesday 4<sup>th</sup> August**

<b>Session 1</b>	<b>Chairperson:</b>	<b>Ahmad Ayesh</b>
9:30 – 9:45	Clare Worley	<b>47 Tuc s-process abundance results from SALT</b>
9:45 – 10:00	David McCarthy	<b>Cluster Coalescence</b>
10:00 – 10:15	Musaed Almalki	<b>Gadolinium Concentration Analysis in Brain Phantom by X-Ray Fluorescence</b>
10:15 – 10:30	Christopher Henderson	<b>Our Neighbouring Interstellar Cavities</b>

**10.30 – 11:00****MORNING REFRESHMENTS – MATH101**

<b>Session 2</b>	<b>Chairperson:</b>	<b>Ahmad Ayesh</b>
10:45 – 11:00	Richard Graham	<b>The road ahead for the UG-2 ring laser</b>
11:00 – 11:15	Young-Wook Song	<b>Laser spectroscopy of InN with trace amount of Magnesium.</b>
11:15 – 11:30	Andre Geldenhuis	<b>Can a better gravity wave climatology be generated using Ensemble empirical mode decomposition.</b>
11:30 – 11:45	Nikolai Kruetzmann	<b>Entropy measures as an indicator for circulation model quality</b>
11:45 – 12:00	Ian Farrell	<b>Growth of metal nitrides by Pulsed Laser Deposition</b>

12:00 – 12:15	Michael Albrow	<b>An Introduction to Markov Chain Monte Carlo</b>
12:15 – 12:30	Duncan Wright	<b>The analysis of non-radial pulsation in stars</b>

**12:30 – 1:30 LUNCH**

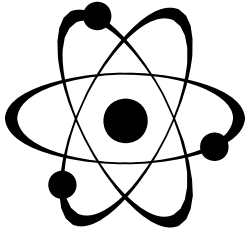
<b>Session 3</b>	<b>Chairperson:</b>	<b>Giles Reid</b>
1:30 – 1:45	Jonathan Stanger	<b>"Electrospinning, Bwah?"</b>
1:45 – 2:00	Marni Sheppard	<b>Operads for Machian Relativity</b>
2:00 – 2:15	Kahae Han	<b>Solar WIMP analysis of AMANDAll data</b>
2:15 – 2:30	Jon-Paul Wells	<b>What do you as a student want to see in University publicity?</b>
2:30 – 2:45	Scott Choi	<b>Eu<sup>3+</sup> Centres in MBE grown CaF<sub>2</sub>:Eu-CdF<sub>2</sub> Superlattices</b>
2:45 – 3:00	Steve George	<b>Chemistry-Climate-Modelling in the Atmospheric Group</b>

**3:00 – 3:30 AFTERNOON REFRESHMENTS – MATH101**

<b>Session 4</b>	<b>Chairperson:</b>	<b>Mita Gopal</b>
3:30 – 3:45	Mike Lee	<b>To be supplied</b>
3:45 – 4:00	Adrian McDonald	<b>Testing measurements made by long-duration balloon flights above the Antarctic</b>
4:00 – 4:15	Andrew Blair	<b>Skin Dose Assessment in Cardiology</b>
4:15 – 4:30	Florentina Baluti	<b>Investigation of optimal properties of chemical vapour deposition diamond detector using Monte Carlo Simulation</b>
4:30 – 4:45	Latoya van der Meer	<b>Combining mild Hyperthermia and Ionizing radiation; Preliminary results of the cell-killing effect on rodent leukaemia cells.</b>
4:45 – 5:00	Roger Reeves	<b>Conference wrap up and discussion.</b>

**CONFERENCE CLOSES**

**Retire to Staff Club for end-of-conference function and presentation of prizes**



## **ABSTRACTS**

**Monday 3<sup>rd</sup> September**

***Anas Sedayo***

### **Improve the contrast of angiogram image by using the Medipix detector based on Monte Carlo simulation**

Angiography is one of the most invasive diagnostic techniques due to both the required contrast medium and the lengthy and numerous x-ray exposures. An angiogram is a medical imaging method where an iodine contrast medium is injected in to the blood vessel of the patient and x-ray images are taken before the injection of the contrast medium, and a series of x-ray are acquire during and after the injection of the contrast medium. The difference between the before and after images shows the blood vessel morphology. When the patient and the organs inside the patient are not moving during the procedure, the subtracted image provides impressive details of the vessel anatomy. When the patient moves between the images, the contrast of the subtracted image is not clear.

Instead of taking two images at different times, it should also be possible to acquire the two images at the same time using different energy x-rays and detectors. After the contrast media injected two images need to be acquired. One image will be acquired at energy where the contrast agent strongly absorbs. The other image will be acquired at a nearby energy where the contrast agent has little or no absorption. The absorption difference takes advantage of the sharp rise of the absorption coefficient of the contrast medium, just below and above the K-edge energy.

The objective of this work is to demonstrate via simulation and experiment that using a broadband x-ray source and the Medipix detector with pixel by pixel adjustments of detection thresholds, it is possible to image the blood vessels in a single image.

***Greg Betzel***

### **Synthetic Diamonds for Radiation Therapy Dosimetry**

Modern techniques in radiotherapy are imposing increasing demands on dosimetry systems. A promising material for radiation detection is the use of diamond, due it's near-tissue equivalence, high resistance to radiation, chemical inertness, and non-toxicity. The current project investigates physical and electronic properties of synthetic diamond films obtained by chemical vapor deposition in order to optimize detector performance and validate their use in clinical setting.

***Suruj Suenarine***

### **Calibrating IceCube PMTs in ice: Parameterization of PMT non-linear response**

The IceCube neutrino detector, described elsewhere at this conference, is currently under construction at the South Pole. It consists of strings of photo multiplier tubes (PMT), with each PMT carrying its own digitization hardware. We are currently attempting to calibrate the PMTs in ice and, in particular, to characterize the saturation of the PMTs. Here we describe that work.

***Veronica Miller***

### **Phase Dispersion Minimisation as a Period Determination Technique in Extra-Solar Planetary Transit Searches**

Conventional searches of large datasets for planetary transit signals are computationally expensive. We investigate here the phase dispersion minimisation algorithm for period determination and its use in recovering transits. We illustrate the method using artificial transits inserted into an observational dataset and compare it with a maximised matched filter grid search.

***Martin Henseler***

### **The Optoelectronic Structure of Bulk ZnO**

ZnO is a wide band gap semiconductor that has the potential to act as a key material for UV-photodetectors, gas sensors, piezo-electronics and spintronics as well as future LEDs and UV-lasing.

Those devices most often require the fabrication of thin films, which can be achieved with growth techniques such as PLD and MBE.

Recently though, bulk ZnO with compelling crystal and electronic qualities became commercially available. To reliably relate the strongly varying properties of thin films grown under various conditions with each other, the high quality bulk ZnO opens a new pathway of getting a better understanding of the material properties of ZnO itself. Properties, that need to be understood to reliably investigate and design thin films and devices.

I will present an insight into the reflective and photoconductive properties of bulk ZnO, and show how carrier concentration and crystal polarity can influence the surface properties via charge compensation.

***Judy Mohr***

### **Atmospheric Turbulence Profiling at MJUO**

Distortion of images due to atmospheric turbulence is one of the major problems in astronomical imaging. To compensate for the induced aberrations in real-time it is vital to have an accurate model of the optical turbulence present at a site. To that end, a bread-board based SCIntillation Detection and Ranging (SCIDAR) system was developed for the Mount John University Observatory (MJUO). The system is constructed from commercially available off-the-shelf components. The modular design provides the flexibility to capture simultaneous pupil-plane and generalised SCIDAR. This provides a useful tool for the measurement of turbulence structure at sites where the near-ground turbulence is exceptionally strong and masks higher altitude turbulent layers. The results taken at MJUO from the purpose-built instrument over the last few years indicate the presence of very strong near-ground turbulence and at least two high altitude layers (approximately 6 km and 11km above sealevel). The resulting profiles vary with the seasons with better viewing in winter months.

***Adam Gillard***

### **Deriving The Veltman Propagator From $(1/2,1/2)$ Representation Space.**

The Veltman propagator, otherwise known as the modified vector boson propagator earned Veltman (and 'tHooft) the 1999 nobel prize in physics. Essentially it boiled down to adding an extra term to the standard vector boson propagator and inserting a minus sign in a convenient place to make things turn out "nice." Here, one of the representations of the Lorentz group, the  $(1/2,1/2)$  representation space is discussed, with a view to understand its connection to the Veltman propagator.

**David Mackenzie**

**Making clusters with Ge ingredients**

Making films of clusters with Ge has proved most interesting with respect to growth of said films. I will explain how this is different to the 'normal' film evolution and discuss solution to the problems encountered.

**James Flewelling**

**Development of clinically-viable applications of MR elastography.**

MR elastography techniques show great promise in classifying the relatively unknown mechanical properties of human tissues. Generating accurate measurements, *in vivo*, of the elasticity of tissue has the potential for greater sensitivity of breast cancer detection and classification, alongside applications for diagnosis of liver, kidney and prostate disease, in sports medicine and even brain research. An overview of elastography is presented here, along with present research into developing MR elastography techniques that are both viable in a clinical setting and that generate enough data to provide a *quantitative* analysis of elastic properties, rather than a mere qualitative examination. Initial results are also presented.

**Casey Tee**

**Copper nanoscale cluster deposition technology for ULSI interconnects.**

K.C., S. A. Brown, R. J. Blaikie

As the integrated circuit technology advances, packing density is required to increase according to Moore's law. At each technology node, interconnect pitch is reduced and the aspect ratio (height/width) is increased. A process with excellent trench filling capability for these dimensions is essential to ensure that key holes are not formed within the metal lines. Here we present a new technique which has been developed to produce copper filled trenches. The damascene structures are filled up with nano-scale copper clusters. It has been demonstrated that nano-scale copper clusters (deposited from a magnetron sputtering source) are able to fill the sub-200nm trenches with up to 5:1 aspect ratio and with high selectivity between the trenches and neighbouring planar surfaces. The high selectivity reduces the need for subsequent processing. The results show that the nano-scale cluster deposition technique has great potential to meet the requirement for ultra-large-scale integrated (ULSI) interconnect metallization.

**Siramas Komonjinda**

**An analysis of GT Muscae - a quadruple system with an active binary star**

In this talk I will presented a summary of research that we have done on a binary star system, GT Muscae. We have a continued observation of this system at Mt John University Observatory for more than 25 years. This system consists of at least four stars orbit each other. The photometric observation shows the variation in brightness due to a spot variation of a RS CVn-type binary (HD 101379) and an eclipse of a short period eclipsing binary (HD 101380). The recent spectroscopic observation using HERCULES combined with available data give us a precise orbital solution. These results give us more information about the nature of activities of this system

**Lou Reinisch**

**Optical fluorescence background in optical fibre scintillator dosimeters**

L. Reinisch<sup>1</sup>, T. Chen<sup>1</sup>, M.A. Alhabden<sup>1</sup>, P. Butler<sup>1</sup>, S. Alzaidi<sup>1</sup>, G. Sorell<sup>2</sup>, M. Bird<sup>2</sup>

<sup>1</sup>Department of Physics and Astronomy, University of Canterbury, Christchurch, New Zealand.

<sup>2</sup>Department of Medical Physics and Bioengineering, Christchurch Hospital, Christchurch, New Zealand.

**Introduction:** We investigated the use of small scintillators attached to optical fibres to use as dosimeter or small area detectors. Background signals induced in the optical fibres were filtered with interference filters.

**Methods:** We investigated three different scintillators (580, 490 and 420 nm), silica and plastic fibres irradiated in a 6MV photon beam from a Varian 600 C linear accelerator. The scintillator was fashioned as a cylinder, 3 mm in diameter and 10 mm long. This was fixed to the 1 mm optical fibre. The scintillator and fibre was irradiated as a function of angle and compared to the fibre, alone, irradiated a function of the incident angle. Exposures of 1 to 1024 monitor units were investigated. 8 cm of solid water was placed below and 1.5 cm of solid water was above the dosimeter. The scintillator signal was separated from the background with an interference filter and the light detected with a photodiode.

**Results:** While the scintillator showed a linear response over the range of exposures measured, the radiation as a function of incident angle was not flat. The geometry is defined with 0° to be irradiation delivered perpendicular to the optical fibre. Irradiation angles pointing away from the photodiode are positive and those angles pointing towards the photodiode are negative. A slight increase in the signal of the fibre alone is noted as the radiation is angled towards the photodiode. A more significant increase in the signal from the scintillator and optical fibre when the radiation was angled towards and away from the photodiode.

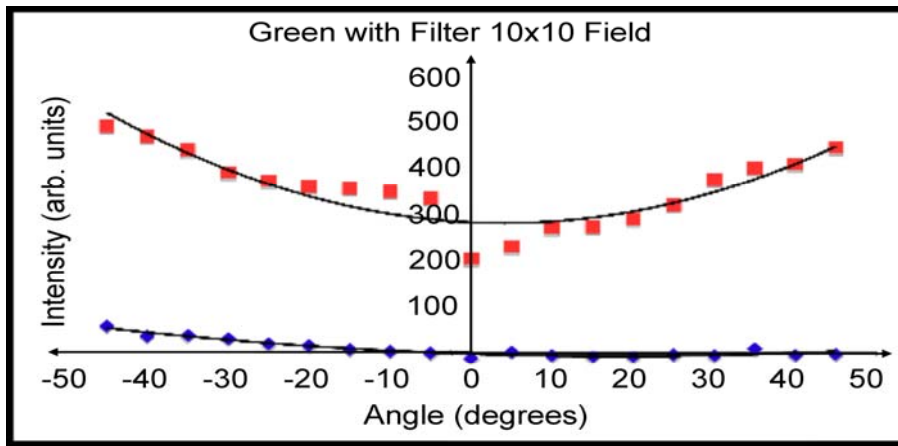


Fig. 1: Measured signal as function of incident angle. The squares are from irradiating the scintillator and optical fibre. The diamonds are from irradiating only the fibre.

**Discussions & conclusions:** Although the optical filters are effective in blocking most of the Cherenkov radiation and fluorescence created in the optical fibre, there is still a significant change in the signal as a function of the incident angle when both the scintillator and optical fibre are irradiated. We can model this angular dependence of the signal as optical fluorescence in the scintillator created by the Cherenkov radiation. This background cannot be filtered with our optical filter system. This background is also not compensated in systems using two optical fibres with a scintillator on only one of the fibres.

***Niels Gresnigt***

**The Casimir operators of the Stabilized Poincare-Heisenberg algebra.**

The Casimir operators of an algebra are operators that commute with all the generators of the algebra. The number of Casimir operators a given algebra has depends on its rank. For the Poincare algebra describing special relativity, there exist two Casimir operators,  $P^2$  and the square of the Pauli-Lubanski vector  $W^2$ . They give us our notions of mass and spin respectively. The stabilized Poincare Heisenberg algebra is thought to describe kinematics at the interface of relativity and quantum mechanics. It has rank three meaning it has three Casimir invariants associated with it. These Casimir invariants are different from those for the Poincare algebra and so we expect our notion of mass and spin to change at the interface of relativity and quantum mechanics.

I will discuss these changes and talk about some of the possible physical implications.

***Ahmad Ayesh***

**Nanocluster devices**

Nanoclusters have special importance in nanotechnology because of their low dimensionality which provides electronic, chemical, and magnetic properties that differ from those of the equivalent bulk materials. Suitably controllable self-assembly methods are required in order to incorporate nanoclusters into useful devices.

The top-down approach was used in this study to fabricate a template. The nanoclusters were self-assembled in the template. The morphology and the electrical properties of the fabricated devices were studied in detail.

***Ruth Peszynski***

**National Radiation Oncology Dose Audit**

Giving the correct radiation dose to cancer patients is important as it has large effects on patient outcome and morbidity. In New Zealand at this time there are currently no external audits of the full dosimetry chain in radiation oncology. This project will devise a procedure to do this audit. Using a CIRS chest phantom and MOSFET detector system, the six oncology centres will treat the phantom as closely to a human patient as possible, so a dose comparison between centres can be carried out.

***Paul Miller***

**The optical characterisation of zinc oxide.**

Zinc oxide (ZnO) is a wide bandgap semiconductor with many interesting optical and electrical properties that make it suitable for such applications as Solar Cells, piezo electric devices, UV lasers, green and orange LED's, and high temperature electronics. It has a wide bandgap of 3.36 eV, a high exciton binding energy of 60 meV and when grown as a high quality film is transparent to the optical part of the spectrum. My research involves characterising the optical properties of ZnO material.

***Ewan Orr***

**Experiments with Graphical Sex**

The goal of my research is to investigate how Machine Learning can be employed to discover rules that govern experimental data. In order for me to have a do-able task I have narrowed my research

space. Firstly, networks of nand gates will represent the discovered rules. Secondly, Genetic Algorithms will be employed to discover these rules.

There are at least three (good) reasons why this talk may be of interest to you.

1. You will be given a simple example of (a very basic kind of) artificial neural network - these are used by other members of the department.
2. You will be given a simple example of a Genetic Algorithm - this technique is relevant to other (other) members of the department.
3. You will be shown an interesting project that tests out some novel ideas

### ***Mita Gopal***

#### **High Resolution Spectral Models for Globular Clusters: Construction of the Models and Application to Local Group Globular Clusters**

We are currently developing high resolution model spectra of simple-stellar-populations for the measurement of chemical abundances in extragalactic globular clusters. The models are well matched to the available spectral resolution and will allow higher precision studies than those employing the traditional Lick index system.

I will describe the construction of the models and present the initial comparisons of the models with moderate resolution, integrated-light spectra of globular clusters in the Milky Way.

### ***Kathleen Monahan***

#### **Atmospheric mixing at the boundary between the stratosphere and troposphere**

The troposphere and the stratosphere each have distinct chemical signatures of ozone and water vapour. It is possible to measure the extent of mixing by examining how these signatures have merged.

Weightings are placed on different mixed states, which are then used to calculate the entropy. Using entropy as a measure of mixing in the system, it is possible to quantify the location and size of the chemically mixed region at the boundary between the stratosphere and troposphere. Entropy also shows a relationship with a number of other physical quantities.

### ***Giles Reid***

#### **Long Range Neutrino Effects**

Neutrino oscillations have been measured over a range distance scales from a few metres (in MiniBoone) to an A.U. (with solar neutrinos). One of the main goals of IceCube is to detect neutrinos from extra-solar and extra-galactic sources. We will discuss some of the unusual effects that may be relevant to the detection of these neutrinos from distant sources.

### ***Clare Worley***

#### **47 Tuc s-process abundance results from SALT**

The spectra of eleven giant stars in the globular cluster 47 Tuc were obtained last year using the medium resolution spectrograph (RSS) on SALT. I will present the latest abundance analysis of these stars for three s-process elements (Zr, Nd and La) and one r-process element (Eu).

***David McCarthy***

**Cluster Coalescence**

Using kinetic monte carlo simulations we are investigating the timescale of cluster coalescence via surface diffusion. Predictions from macroscopic theories are tested for various cluster sizes and temperatures, and deviations from the theory are discussed.

***Musaed Almalki***

**Gadolinium Concentration Analysis in Brain Phantom by X-Ray Fluorescence**

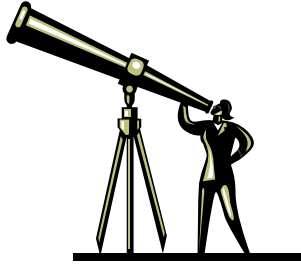
In recent years gadolinium received high attention in research in neutron therapy. The element has the highest absorption cross section for slow neutrons. The energy available from  $(n, \bar{\alpha})$  reaction following neutron absorption can be used for delivering dose to an organ in which the element is localized. In this process most of the energy from the reaction is deposited into tumor and only insignificant dose goes to normal tissue. Accordingly information on concentration, build-up or elimination of gadolinium from an organ can be of great significance in gadolinium neutron therapy. In this research, it is intended to show the x-ray fluorescence intensity can be correlated to known gadolinium concentrations in a phantom brain tumor.

Radiation from 1 Ci (37 GBq) Americium-241 is allowed to be incident on the phantom tumor. Following absorption of radiation by gadolinium atoms, characteristics x-rays are emitted and measured by detector. Reabsorption and scattering effects are quantified.

***Ben Leith***

**Multi-scalar black holes**

I will present some recently found solutions to multi-scalar black holes coupled to electromagnetism. We find that these black holes have some novel features, the extremal black hole solutions are found to have finite and varying temperature in general rather than the expected zero temperature. These solutions also happen to be linearly stable solutions with 'hair' meaning they exhibit more degrees of freedom than hypothesised by the uniqueness theorems for black holes.



## ABSTRACTS

Tuesday 4<sup>th</sup> September

***Christopher Henderson***

### **Our Neighbouring Interstellar Cavities**

The Sun is located inside a rarified region of space with a boundary of neutral gas. This "Local Bubble" is surrounded by other such regions, and tunnels form where these regions connect and interact. I will outline my Masters research, where I am using spectra obtained from the Mount John observatory to map out two such tunnels in the southern sky; I aim to be able to map the shape and extent of these tunnels with a higher resolution than has been done before.

***Richard Graham***

### **The road ahead for the UG-2 ring laser**

In September 2000, a new ring laser gyro designated UG-1 was completed.

Generally we expect the accuracy and resolution of a ring laser gyro to increase with size. With an area of some 370 m<sup>2</sup>, UG-1 was by far the largest active ring laser gyro ever constructed. It allowed new measurements to be made, for example the landmark 2004 measurement of polar wobble.

In 2005, UG-1 was expanded to form UG-2, a 840 m<sup>2</sup> device. Sadly, the performance of UG-2 as a rotation sensor is in general not as good as UG-1. This talk will present the idea of a virtual-monolith ring laser, a modification that may allow the full potential of UG-2 to be realised.

Also, I will detail our immediate plans for conversion of UG-2 to a hybrid device intended to allow UG-2 to be reconfigured on-the-fly to a smaller device.

***Young-Wook Song***

### **Laser spectroscopy of InN with trace amount of Magnesium.**

Indium Nitride (InN) is a direct band semiconductor which is the least understood in the group III-nitride compound. InN has had much interest recently due to a debate regarding the energy bandgap of the material. Since InN is confirmed to be narrow band gap about 0.7eV rather than 1.9eV which allows -nitride alloys can cover very wide range of wavelength from 200nm to 2000nm. Increasing large number of applications of group III-V semiconductors in technological applications has intensified the importance of investigating p type InN. Due to similar length of atomic radius with Indium (In), Magnesium (Mg) was firstly doped in this investigation. The general aim of this research

is to investigate Mg doped InN thin films, using spectroscopy in the energy region 0.5-0.8eV in order to reveal the properties of p type InN. The samples were grown locally in Electrical Engineering department by Molecular Beam Epitaxy (MBE) with various Mg cell temperatures. The samples have been characterized using Photoluminescence (PL) experimental techniques and a peak in the PL emission intensity was observed in the energy range 0.6~0.7eV.

***Andre Geldenhuis***

**Can a better gravity wave climatology be generated using Ensemble empirical mode decomposition.**

Using MF-radar data, climatologies of atmospheric gravity waves are generally prepared by least squares fitting techniques. Known period waves, such as atmospheric tides, are removed and the residual is assumed to be primarily due to gravity waves. This approach is limited as the atmospheric waves which are fitted, have periods which vary non-linearly. A new signal processing technique known as Ensemble Empirical Mode Decomposition has the potential to fit these non-linear period waves, additionally it appears to have strong noise rejection ability. This technique is compared to the least squares fitting technique to determine if it can produce superior gravity wave climatologies.

***Nikolai Kruetzmann***

**Entropy measures as an indicator for circulation model quality**

My research considers two methods of calculating statistical entropy in order to use it for analyzing and comparing the complexity of measured and simulated climatological data. While sample entropy proves to be very useful for analyzing time-series, Rényi entropy can be used on 'non-temporal' data, such as common (zonal-) averages around a circle of latitude. I use Rényi entropy to analyze atmospheric mixing - which is a major source of climate complexity - using data from simulations of the chemistry-climate-model SOCOL (which runs on the UC supercomputer). I find clear patterns, similar to the ones that have been identified by previous studies of mixing and now aim to use it as a tool to analyze the modelling quality of SOCOL, but without looking at absolute values and weather they precisely match observational data.

***Ian Farrell***

**Growth of metal nitrides by Pulsed Laser Deposition**

In my talk I will describe the growth and characterisation of metal nitrides, primarily GaN, by Pulsed Laser Deposition. These are the first materials to be grown in the newly commissioned Ultra High Vacuum chamber and as such represent something of a learning curve. I will outline the evolving growth procedure and present an analysis of materials grown to date.

***Michael Albrow***

**An Introduction to Markov Chain Monte Carlo**

For problems involving large numbers of parameters, gradient- or grid-based solution methods are inefficient and often do not converge. I will show how Markov Chain Monte Carlo methods can be used to efficiently solve such problems.

## ***Duncan Wright***

### **The analysis of non-radial pulsation in stars**

I will give a brief overview of non-radial pulsation in stars and then look at methods of identifying the specific mode(s) of oscillation from spectroscopic observations. The analysis of the gamma Doradus variable QW Puppis and the delta Scuti star FG Virginis will be used as examples of the applications of these methods.

## ***Jonathan Stanger***

### **"Electrospinning, Bwah?"**

To the great honor of the physics department at canterbury, they have allowed me, in the spirit of universities of old to pursue research that is outside of what the department normally does. In light of this I wish to explain a little about what I'm studying and why its important. I am studying the process of electrospinning. It is a method of creating continuous fibre from a polymer solution using electrostatic forces. What is unique about this process is that it can produce fibres with a diameter of between a few microns to less than 100nm and still maintain a continuous fibre production. It does not need special atmospheric conditions and consumes very low quantities of power. The factors that affect this process demand that to understand the full process a multi disciplinary study be undertaken. Understanding of the entire process, from the over all chaotic seeming dynamics to the fundamental driving and limiting factors, is something yet to be achieved even with the long history of study. Despite being patented in 1904 the process has yet found commercialization. I believe this is due to the incomplete understanding of how to control the process rather than a lack of applications. Some applications already proposed include tissue scaffolds for organs, skin or neural cells, composite manufacture, filtration elements, super capacitors, lithium ion batteries, sensors or sensor substrates and routes to producing materials with a critical strength closer to their theoretical maximum. One of the most exciting possibilities is that this process can be used with biopolymers as well as the classical technical polymers. This would mean that the above applications could be undertaken with renewable resources, relieving some strain on our depleting oil reserves

## ***Marni Sheppard***

### **Operads for Machian Relativity**

Although Mach's writings inspired Einstein, General Relativity was not quite successful in incorporating his principle for inertia. The mathematical framework of categorical quantum gravity approaches Machian inertia via the physics and logic of quantum computation, usually in the guise of a holographic principle. In this talk the meta-algebraic concept of /operad/ is introduced. Operads offer concrete combinatorial tools for dealing with holography outside of conventional geometry.

## ***Kahae Han***

### **Solar WIMP analysis of AMANDAII data**

I will talk about some methods used in the WIMP analysis on the AMANDA II data, and focus on some specific aspects including generation, reconstruction and filtering methods applied.

**Jon-Paul Wells**

**What do you as a student want to see in University publicity?**

**Scott Choi**

**Eu<sup>3+</sup> Centres in MBE grown CaF<sub>2</sub>:Eu-CdF<sub>2</sub> Superlattices**

A study of defect centres in nano-scale materials has been undertaken. Molecular beam epitaxy (MBE) has made it possible to grow superlattices of CaF<sub>2</sub>-CdF<sub>2</sub> with layer thickness as thin as 2 mono layers. During the growth Europium (Eu) ions are selectively doped into the CaF<sub>2</sub> layers as an optical probe. Eu ions in a cubic centre are dominant seen from photoluminescence measurement. Combined excitation and emission spectroscopy revealed a new centre of Eu that is strongly depend on the layer thickness. This centre is only present within thin superlattices. The transition energies of the new centre are slightly shifted from the cubic Eu centre (0.22nm in emission and 0.07nm in excitation). Interaction at the interface seems to be the cause of the observation of the new centre of Eu. In this talk a possible role of conduction band electrons in CdF<sub>2</sub> is discussed.

**Steve George**

**Chemistry-Climate-Modelling in the Atmospheric Group**

The presentation will discuss recent work with the SOCOL chemistry-climate model (CCM). SOCOL combines a full, dynamical model of the lower and middle atmosphere with a chemistry transport model. The Atmospheric Group is particularly interested in using the CCM to investigate ozone hole recovery, and said recovery's impact on potential anthropogenic warming signals in the southern hemisphere. Locally implemented model improvements will see SOCOL more suitable to said task, and such changes will be addressed.

**Mike Lee**

**To be supplied**

**Adrian McDonald**

**Testing measurements made by long-duration balloon flights above the Antarctic**

In 2005 the VORCORE campaign launched 27 long-duration balloons from McMurdo base in Antarctica. Unlike normal weather balloons these are super-pressure balloons which can withstand the extreme environment in the Antarctic stratosphere ( roughly 20km above the surface) for up to 90 days. This study compares temperature and wave activity measures made by instruments on these balloons with data from the CHAMP radio occultation satellite which is known to be extremely well calibrated. The potential of the Lagrangian measurements made by the balloons for gaining an insight into fundamental atmospheric processes is also detailed.

**Andrew Blair**

**Skin Dose Assessment in Cardiology**

Currently the radiation risk to patients undergoing interventional procedures is gauged by using the inaccurate dose area product and the total fluoroscopy time. This is a poor indicator for a number of reasons which I will discuss. This thesis involves producing a system that can be used to accurately estimate radiation dose to the patient and that is user friendly. Current work with Radiochromic film will be discussed along with future plans.

**Florentina Baluti**

### **Investigation of optimal properties of chemical vapour deposition diamond detector using Monte Carlo Simulation**

Intensity Modulated Radiation Therapy (IMRT) and stereotactic radiotherapy (SRT) uses small field sizes. For these fields a desirable detector would be a tissue equivalent material with good spatial resolution and high sensitivity.

Radiation dosimetry based on synthetic diamond made by a chemical vapour deposition process (CVD) presents a growing interest due to the availability of the relatively cheap synthetic diamond materials with respect to the expensive natural diamond.

We are planning to develop a CVD diamond detector to be used in the small radiation field like IMRT or SRT. Before constructing the physical detector, it will be important to optimize the detector properties using Monte Carlo (MC) simulation. In my MSc project I am planning to use MC simulation to investigate different aspects of CVD detector properties such as size, shape, doping impurity in the CVD, electrode materials and their orientations. These investigations will lead us to develop our ideal CVD diamond detector.

In my presentation I will give some directions of my research work.

**Latoya van der Meer**

### **Combining mild Hyperthermia and Ionizing radiation; Preliminary results of the cell-killing effect on rodent leukaemia cells**

L. C. A. Flewelling<sup>1</sup>, J. Meyer<sup>2</sup>, M. Bird<sup>3</sup>, L. Reinisch<sup>4</sup>

<sup>1, 2, 4</sup> Department of Physics and Astronomy, University of Canterbury, Christchurch, New Zealand.

<sup>3</sup> Oncology Service, Christchurch Hospital, Christchurch, New Zealand.

**Introduction:** Total body irradiation (TBI) applied to patients with leukaemia prior to a bone-marrow transplant can result in significant adverse effects such as radiation pneumonitis in the lungs [1]. Such side effects are likely to be minimised by reducing the overall radiation dose while maintaining the same cell-killing effects in combination with other means. One possible approach to accomplish this is to combine ionizing radiation with mild hyperthermia. Only limited data are available in the literature for this combined approach regarding leukaemia. In this study, basic *in vitro* experiments are undertaken to investigate whether leukaemic cells become more radiosensitive when subjected to mild hyperthermia.

**Methods:** P388 leukaemia mouse lymphoid cells were grown *in vitro*, dispensed in plate-wells and placed in an incubator. Cell-survival curves for hyperthermia were obtained by varying the temperature in the incubator and measuring the cell-kill over a period of days. The curves were corrected for natural cell-kill in an unexposed control group. As the cells were grown at the University of Canterbury and needed to be transported to Christchurch Hospital biohazard safety containers to house the cells during transport were constructed. The possibility of keeping the temperature of the cells constant at 37 degrees Celsius during transportation was investigated. Preliminary experiments were carried out to calculate the build-up material needed for our final experimental set-up. The cells were then irradiated with x-rays for a range of doses, and the cell-survival curve for ionizing radiation alone was obtained. When combining hyperthermia with radiation the maximum cell-kill occurs when both treatments are delivered simultaneously [2]. As this was not possible with our experimental set-up, the cells were returned immediately to the University of Canterbury after irradiation at Christchurch Hospital and underwent hyperthermia there. The cells that survived were characterized by their ability to continue to metabolise dye and were counted using a spectrophotometer. Cell-survival curves were generated and compared to cell-kill by both hyperthermia and radiation alone.

**Results:** A cost effective transportation protocol was constructed to be biohazard safe. To maintain the cells at a constant temperature of 37 degrees Celsius a large thermal mass of water surrounded the biohazard safe containers throughout transportation. The cell-survival curves resulting from this research are currently being analysed and will be presented during the conference. Ministry of Agriculture and Forestry approval for this project is underway.

**Discussions & Conclusions:** The basic *in vitro* experiments undertaken in this study are an initial step toward developing an understanding of heat as a radiosensitizer for leukaemia cells. The effects of the combined modality technique on response to tissue are much more complex than the *in vitro* system we investigated. This is due to important physiological changes produced by hyperthermia when applied *in vivo* [3]. Thus, further work that observes the effects of total body irradiation combined with whole body hyperthermia is required.

**References:**

- <sup>1</sup> T E Wheldon, (1997) *The British Journal of Radiology*, **70**: 1204-07.
- <sup>2</sup> J R Stewart, F A Gibbs Jr, (1984) *Cancer*, **54**: 2823-30.
- <sup>3</sup> H D Suit, M Shwayder, (1974) *Cancer*, **34**: 122-29.

**Roger Reeves**

**Conference wrap up and discussion**

This slot is to provide some feedback on some of the issues that are affecting the Department. For example

- 1) The visit of the VC on 25 Sept
- 2) Where the College Plan is currently at
- 3) What the outlook for 2008 presents

## NOTES FOR SPEAKERS



1. Please keep your presentation to the allocated time of 10 minutes. 5 minutes is allowed for discussion after your talk.
2. A computer and data projector will be available. Please load your presentations onto it before the start of your session from a memory stick or CD.

## RESEARCH STUDENT TALKS

The B.G. Wybourne prize will be awarded for the best research student talk while the Department will be awarding prizes for 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> placed research student talk.

Last year the B G Wybourne Prize went to Richard Graham and the Department prize was shared by Mita Gopal, Mike Lee and Petra Huck.

## AFTER CONFERENCE GATHERING

Members of the Department are all welcome to attend the end-of-conference BBQ and prize-giving to be held at the Staff Club following the last talk.

