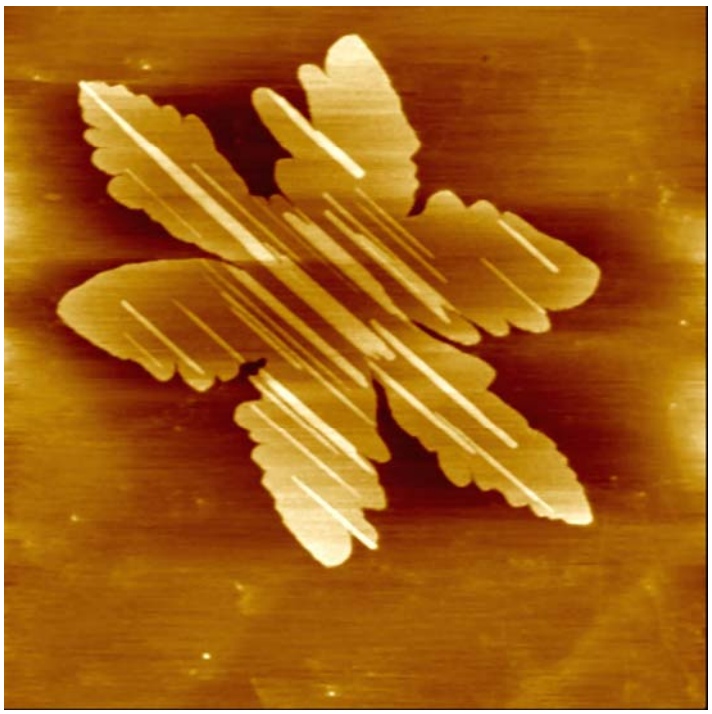
DEPARTMENT OF PHYSICS & ASTRONOMY
College of Science

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

21st DEPARTMENTAL CONFERENCE

Thursday 1st September & Friday 2nd September 2005
LAWS108



Nanostar (*Shelley Scott*)

Programme

Thursday September 1st

Session 1	***Chairperson:***	***Michael Albrow***
1.30 – 1:40	**Phil Butler**	*Welcome*
1.40 – 1.55	**Pauline Harris Rongomaiwahine/Ngati Kahungunu**	
1.55 – 2:10	**Ahmad Ayesh**	*Nanomaterials*
2.10 - 2.25	**Siva Sarasanandarajah**	*Principal Component Analysis of Fluorescence Data to probe the effect of hydration on Identification of Bacillus spores*
2.25 - 2.40	**Andreas Baumgaertner**	*Combined Observations of Atmospheric Tides with The Scott Base and Halley Bay Radar*
2.40 - 2.55	**William Joyce**	*Role of Category theory in physics*
2.55 - 3.10	**Joseph Kunnil**	*Fluorescence quantum efficiency of dry 'Bacillus' spores*
3.00 – 3.30	***AFTERNOON REFRESHMENTS***	
Session 2	***Chairperson:***	***Alex Neilsen***
3.30 - 3.45	**Ian Farrell**	*Design and operation of a Pulsed Laser Deposition System for thin film growth*
3.45 - 4.00	**Steve Churchwell**	*Electromagnetic Ray Tracing and a Level 3 trigger for RICE*
4.00 - 4.15	**Siramas Komonjinda**	*A study of orbital eccentricities in close binaries using high resolution CCD échelle spectra*
4.15 – 4.30	**Martin Kaufmann**	*The Risks of Nanotechnologies*
4.30 – 4.45	**Ben Leith**	*Type Ia Supernovae in a Fractal Bubble Universe with No Cosmological Constant*
4.45 – 5.00	**Paul Miller**	*Growth of ZnO thin films by pulsed laser deposition*

CLOSE OF DAY ONE

Friday September 2nd t

Session 3	***Chairperson:***	***Duncan Wright***
9.00 - 9.15	**Tom Chen**	*Scintillator Wavelength Influence In An Optical Dosimeter*
9.15 - 9.30	**Marni Sheppeard**	*Quantum Logic in Pointless Topology*
9.30 - 9.45	**Michael Chappell**	*What do the brains of boxers, rugby players, and Soccer players have in common?*
9.45 - 10.00	**David Wojtas**	*Exact lattice calculations in non-linear field theories*
10.00 -10.15	**Martin Henseler**	*Optical and photoelectrical properties of ZnO thin Films and the effects of annealing*
10.15 - 10.30	**Malcolm Cropp**	*CCD Photometric Analysis of Stellar Clusters*
10.30 – 10.45	**Steve Marsh**	*Very Large Ring Laser Gyros – where are they heading?*

10.45 – 11.00 MORNING REFRESHMENTS

Session 4	***Chairperson:***	***Kate Monahan***
11.00 - 11.15	**Alex Neilsen**	*New Horizons for Black Holes*
11.15 - 11.30	**Veronica Miller**	*Search for Extra-solar planets via the transiting method: A survey*
11.30 - 11.45	**Kate Monahan**	*Stratosphere Troposphere Exchange in the Southern Hemisphere*
11.45 - 12.00	**Damien Carder**	*Nitride-based Semiconductors*
12.00 – 12.15	**Veronica Cahyadi**	*Lecturers', tutors' and students' experiences on Real-life materials in introductory physics courses*
12.15 – 12.30	**Karla Kincaid**	*Energy windowing using the MEDIPIX2 silicon x-ray detector*
12:30 – 12:45	**Michael Albrow**	*SALT: Telescope, Instrumentation and Science Programmes*

12.45 – 2.00 LUNCH

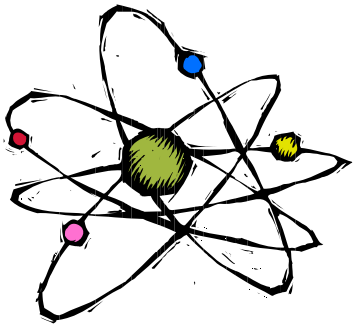
Session 5	***Chairperson:***	***Martin Kaufmann***
2.00 – 2.15	**Beth Geraghty**	*Investigation and numerical comparison of Resonance along the East coast of New Zealand Using GEOWAVE V1.0*
2.15 - 2.30	**Mike Lee**	*Energy Transport in Quantum Percolation Models*
2.30 – 2.45	**Rene Reichel**	*Atomic Cluster Nanodevices*
2.45 – 3.00	**Adrian McDonald**	*Convective Gravity Waves at Mid-Latitudes*
3.00 – 3.15	**Ben Carter**	*Stable gravastars with generalized exteriors*
3.15 – 3.30	**Anthony Gomez**	*Searching for Dark Matter with Neutrino Telescopes*

3.30 – 3.45 AFTERNOON REFRESHMENTS

Session 7	***Chairperson:***	***Phil Butler***
3.45 – 4.00	**David McCarthy**	*Atomic Diffusion of Bismuth*
4.00 – 4.15	**Duncan Wright**	*Results from a campaign on two gamma Doradus variables*
4.15 – 4.30	**Ewan Orr**	*Category Theory and the Scientific Method*
4.30 – 4.45	**Jonathan Griffin**	*Equipment for Radiation Dosimetry of Irregular Shapes*
4.45 – 5.00	**Ishwaree Neupane**	*Towards inflation in string cosmologies*
5.00 – 5.15	**Elizabeth Wylie**	*Element Abundances in AGB Stars of 47 Tucanae*

CONFERENCE CLOSES

Retire to Room P701 for end-of-conference function and presentation of prizes



ABSTRACTS

Thursday 1st September

Title

Pauline Harris Rongomaiwahine/Ngati Kahungunu

In the fireball phenomenology of Gamma Ray Bursts (GRBs) it is expected that the observed photons are accompanied by ultra-high energy neutrinos. Neutrinos originate in the decays of pions which would be produced when charged particles, accelerated in the shock front of the GRB, interacted with dense clouds of radiation or matter surrounding the GRB. We describe the physics behind the expected neutrino spectrum and the variation in the spectrum that is expected between individual bursts.

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Nanomaterials

Ahmad Ayesh (Simon Brown, Jim Partridge, Rene Reichel)

Nanomaterials have received a great deal of attention since the end of the last century because of their potential applications in many fields in physics, chemistry, engineering and biology. When the material dimensions are reduced to be in nanosize, the material shows new properties which are different from the properties of the equivalent bulk materials. The reduced dimensionality also has a scientific importance since it provides a suitable media to study the quantum properties since the electrons will be confined inside the material.

In my talk I will go through some of the physical properties of materials and explain how they become different when the material dimensionality is reduced.

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Principal Component Analysis of Fluorescence data to probe the effect of hydration on identification of Bacillus spores

Siva Sarasanandarajah

High sensitivity, short-collection time, and no sample contact render fluorescence methods attractive for the investigation of many biological pathogens that adversely affect human health. Bacterial spores are the survival stage of certain bacteria and can persist for decades in a variety of harsh environments and when conditions permit (such as inside a human) may develop into a vegetative bacterium. The dimensions of individual bacterial spores differ significantly depending upon species, growth regimes and environmental conditions. The intrinsic steady-state fluorescence excitation--emission spectra of spores on filter paper in a quartz cuvet were measured at 45 degrees to the exciting light at room temperature with excitation wavelengths from 200 nm to 600 nm. Initially, the fluorescence emission spectrum of sample in dry form is measured. Then a small amount of sterile deionized water is pipetted to the bottom of the cuvet. The sample is allowed to stand for 15-20 min to allow the water to wick up the filter paper and for the spores to wet and hydrate. The fluorescence emission spectrum of wet sample is measured. We used four different species of *Bacillus* spores: *B. globigii, B. cereus, B.popilliae* and *B. thuringiensis.* Classification of dry and wet spores based on their fluorescence finger

prints was performed using principal component analysis (PCA).The fluorescence results using PCA indicates clear, identifiable differences among spore species. Differences are also observed between dried and wet spores, indicating the strong effect of hydration on the fluorescence finger prints. The differences are spore species-specific and provide a direct insight into molecular architecture and structural variability of different bacterial endospores in wet and dry environments. Spore identification could be enhanced by measuring both the dry and wet spores and observing the changes in the fluorescence spectra between these two states. The detection and identification techniques of *Bacillus* spores relying on fluorescence must take into account the hydration state of the spores.

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Combined Observations of Atmospheric Tides with the Scott Base and Halley Bay Radar

Andreas Baumgaertner

The Scott Base radar makes observations of winds in the middle atmosphere, where atmospheric waves often dominate the observed flow. The tidal waves we discuss in this presentation are planetary scale oscillations in temperature, pressure and wind velocity with periods of one day and its harmonics. These waves are generated by the absorption of solar radiation in the atmosphere. In particular, water vapour absorption of infrared radiation in the troposphere and stratospheric and lower mesospheric ozone absorption of ultraviolet radiation are important. This presentation will discuss the comparison of tides measured at Scott Base and the Halley Bay Antarctic station, operated by the British Antarctic Survey. Examination of the differences between the observations at these two sites allows us to draw conclusions about the structure of the tide along a latitude circle. This information also makes it possible to understand the dominant types of tides observed. In addition these cooperative measurements allow the likely generation processes for these tidal modes to be identified.

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Role of Category theory in physics

William Joyce

From its narrow beginnings in algebraic topology of the 1940s, category theory has blossomed to permeate mathematics, physics, computer science, engineering, philosophy and linguistics. In mathematics it provides a frame to describe all mathematical concepts and a language to study the foundation of mathematics. It is the language of theoretical computer science. It provides models for logic and semantics.

In physics, category theory underlies the structure of many body quantum theories including quantum field theory, topological field theory and conformal field theory. It provides the framework for algebraic geometry and the sheaf approach to differential geometry and gauge theory.

The intention is to provide a glimpse into the categorical approach to science.

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Fluorescence quantum efficiency of dry 'Bacillus' spores

Joseph Kunnil

Fluorescence spectroscopy has been used to measure fluorescence quantum efficiency (*QE*) of dried *Bacillus* spores (washed and unwashed) fixed to a quartz substrate. Fluorescence spectra and *QE* of anthracene in ethanol was used as the standard. We measured the absorption and fluorescence signal of the spores as a function of the number of spores. The absorption was measured from 600 nm to 250 nm using the reflectance in an integrating sphere. The fluorescence spectra were measured using excitation wavelengths at 280, 360 and 400 nm at room temperature. The absorption cross sections for the unwashed spores were $1.3 \times 10^{-}$, 8×10^{-9}, and 5×10^{-9} mm^2/spore at 280, 360 and 400 nm, respectively. The *QE* decreased by a factor of 2, 4 and 4 at these same wavelengths after washing and redrying the spores.

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Design and operation of a Pulsed Laser Deposition system for thin film growth

Ian Farrell

In my talk, I will describe the design and operation of the Pulsed Laser Deposition (PLD) system in the new 6th floor labs. This system is a very versatile and interesting way of growing optoelectronic thin film materials owing to some unique advantages inherent to its design. I will outline the PLD process and describe some of the key material systems that we have the potential to investigate. Finally, I will present the results of investigations into the nitrogen species created by the plasma source and how these results are likely to affect material growth process.

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Electromagnetic Ray Tracing and a Level 3 trigger for RICE

Steve Churchwell

I will describe how EM waves propagating through a varying index of refraction are affected by the material and how the Eikonal equation can be used to predict where "rays" will go. The theory will then be applied to radio waves in Antarctic ice. More specifically, the problem of working backwards from several radio receivers to determine the position and time of a source vertex will be described. Finally, our current implementation of this problem in the real-time software trigger for RICE II, the so-called "level 3 trigger" will be outlined.

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A study of orbital eccentricities in close binaries using high resolution CCD échelle spectra

Siramas Komonjinda

We have initiated a program to study the distribution of orbital eccentricities in a number of late-type close binary stars already known to have nearly circular orbits. Our aim is to measure the orbital parameters with high precision using CCD échelle spectra, and to investigate whether precise or approximate circularization of the orbit has taken place on the timescales expected theoretically. Results for one initial system observed with HERCULES (ζ TrA, F9V) indicate a small but highly significant residual eccentricity of e = 0.01442 $\pm$ 0.00021. This demonstrates that our instrumentation can deliver highly precise orbital parameters. However ζ TrA is probably much younger than the circularization timescale or its orbit. HD30021 is the first star in a new program on low eccentricity binaries, and the preliminary analysis of this system also show a small but significant eccentricity of e = 0.00215 $\pm$ 0.00033.

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The Risks of Nanomaterials

Martin Kaufmann

Nanotechnologies are widely seen as having huge potential to bring benefits to many areas of research and application, and are attracting increasing investments from governments and businesses all around the world. At the same time, it is recognized that their application may lead to new risks and raise ethical questions. In my talk, I will present an overview of some of the risks and challenges involved.

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Type Ia Supernovae in a Fractal Bubble Universe with No Cosmological Constant

Ben Leith

We statistically test the recently proposed Fractal Bubble model (gr-qc/0503099) against the current Type I1 Supernovae Data. This model is one of many inhomogeneous models trying to deal with the current epoch of cosmic acceleration observed without the need to revert to a cosmological constant. We compare it to the standard cosmological constant model.

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Growth of ZnO thin films by pulsed laser deposition

Paul Miller

ZnO is a wide bandgap semiconductor with many interesting optical and electrical properties than render it suitable for such applications as Solar Cells, piezo electric devices, UV lasers, LED's, and high temperature electronics. It has a wide bandgap of 3.36eV, 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.

In my presentation I will discuss our initial attempts at growing ZnO thin films by pulsed laser deposition (PLD), and present results pertaining to their physical and optical characterisation.

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Friday 2nd September

Scintillator Wavelength Influence In An Optical Dosimeter

Tom Chen

Plastic scintillators have been widely used in physics and in the medical field to measure ionising radiation. Several investigators have attempted to attach small plastic scintillators to optical fibres to make *in-vivo* dosimeters. However, Cerenkov radiation and fluorescence in the optical fibre creates a variable background signal that can interfere with the readings from such a dosimeter. Instead of using the traditional high efficiency blue or violet scintillator, we are investigating whether lower efficiency red and green scintillators can be used. The longer wavelength light created by the green and red scintillators allow us to more effectively filter out the Cerenkov and fibre fluorescence. To test these new scintillators and optical filters, we will measure the light intensity as a function of the incident angle of the irradiation on the scintillator and fibre. We can, thereby, separate the Cerenkov light from the other sources of light. The lower efficiency of the longer wavelength scintillators can also be compensated by using a diode detector with greater sensitivity in the red part of the visible spectrum. We expect an overall net gain in the useful range of the longer wavelength scintillators.

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Ribbons, Knots and Chain Mail

Marni Sheppeard

Higher Categorical Algebra is the mathematics that unifies gravity and quantum physics. This talk focuses on the relation between three dimensional algebras and physical constructs such as 6j symbols.

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What do the brains of boxers, rugby players, and soccer players have in common?

Michael Chappell

Using an MRI technique called diffusion tensor imaging (DTI) that is sensitive to the diffusion of water in the brain, it is possible to get information about the microstructure of the brain. This makes it possible to localize brain damage in vivo, which has not been possible to this extent before DTI. This has immediate diagnostic power for studying head injuries from sport, and researchers are also seeing if different neurological diseases such as Parkinsons have their own microstructural “signatures”. My study of the brains of 81 professional boxers has shown that effects of cumulative, chronic blows to the head are greater than had previously been realised.

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Exact lattice calculations in non-linear field theories

David Wojtas

Lattice simulations are often the only tool to explore the physics of complicated nonlinear field theories. An obvious limitation of such an approach is that, although field theories are continuous and usually formulated in an infinite volume, lattice simulations are discrete and finite, imposing both a maximum (size of the box L) and minimum (lattice spacing Δx) wavelength that can be probed by the simulation. When one considers a quantum system or a system coupled to an external thermal bath, fluctuations will be constrained within the allowed range of wavelengths, leading to discrepancies between the continuum formulation of the theory and its lattice simulations. Exact methods that account for the dependence on lattice spacing exist for (1+1)-dimensional scalar field theories and prove very successful. However, they do not easily generalize to higher dimensional field theories. I will speak on a few possible alternatives.

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Optical and photoelectrical properties of ZnO thin films and the effects of annealing

Martin Henseler (W.C.T. Lee, P. Miller, S.M. Durbin, R.J. Reeves)

With a bandgap of 3.4 eV at room temperature and a high exciton binding energy of 60 meV, ZnO is a very attractive new material for room temperature excitonic optoelectronic applications. In particular, the goal is to fabricate high resistivity, low carrier concentration and high mobility material that allows efficient p-type doping to take place. Even so, the optical properties are still as important, as it is the optical response of the ZnO thin films that will be used for the actual application.

Single crystalline ZnO thin films were grown at a comparatively low growth-temperature, using plasma-assisted molecular beam epitaxy. The effect of post growth annealing was studied, using Photoluminescence and Photoconductivity for characterization.

The PC measurements of the annealed films show strong multipeak features at the band-edge. Calibrated measurements of Pl vs. PC are done towards a better understanding of those features, including thermal and kinetic considerations.

PL measurements of the annealed samples show a decrease of the FRHM with an improvement of the Bandedge-PL intensity. This indicates that the annealing has an effect of reducing the strain caused by the lattice mismatch between the sapphire-substrate and the ZnO-thin film.

Defect related lines in the low-energy region are created as well in the process of annealing though, and the annealing temperature has to be chosen carefully.

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CCD Photometric Analysis of Stellar Clusters

Malcolm Cropp

I will present the latest results from my ongoing analysis of my observations of three stellar clusters: two open clusters within our galaxy and one globular cluster.

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Very Large Ring Laser Gyros

Steve Marsh

In December 2004 we completed construction of UG-2, the largest ring laser gyro in the world today. It is 3 orders of magnitude larger than the first one built in the department, which was already 2 orders of magnitude larger than the "usual" ones of the time. The generic reasons for going very large are discussed. The absolute accuracy of measurement of rotation rate can be verified at the level of 10 ppm by comparison with surveyed dimensions, but accuracy beyond that level must be indirectly inferred. Estimates are given for our current largest laser, and compared with what would be required to measure interesting geophysical and fundamental physical effects.

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New Horizons for Black Holes

Alex Neilsen

I'll discuss some new ideas in Black Hole physics, including possible solutions to the famous "Black Hole Information Paradox".

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Search for extra-solar planets via the transiting method: A survey

Veronica Miller

A survey is being undertaken in a stellar field of the Galactic Bulge to search for extra-solar planets via the transiting method. The observations are being performed on the ESO 2.2m telescope in Chile and will then be analysed for extra-solar planets. I present here the basis of the survey including the likelihood of finding extra-solar planets in this field and the methods by which they will be found.

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Stratosphere Troposphere Exchange in the Southern Hemisphere

Kate Monahan

Air parcels in the atmosphere have characteristics depending on the region of the atmosphere they originate in. When air parcels move across the tropopause from either the troposphere to the stratosphere, or vice versa, these movements can be tracked by examining these characteristics. Using data from ozonesondes released from Lauder in Central Otago, and from the NCEP/NCAR reanalysis model, possible regions of stratospheric air in the troposphere have been identified.

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Nitride-based Semiconductors

Damian Carder

Nitride-based semiconductors have already made a huge impact in the optoelectronics industry, with the compound Gallium Nitride (GaN) routinely used in commercially available light emitting devices. To fully exploit this class of semiconductor a greater understanding of nitride alloys is required. At Canterbury current research is focused on the growth and characterisation of Indium Gallium Nitride (InGaN). Emphasis is placed on indium-rich material, with particular interest towards the binary system of Indium Nitride (InN).

This talk will outline the motivation and objectives of this inter-departmental research (highlighting the role of this department), along with a discussion of the current status of the project.

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Lecturers', tutors' and students' experiences on real-life materials in introductory physics courses

Veronica Cahyadi

This talk presents the experiences of lecturers, tutors and students in encountering real-life materials in introductory physics courses. These materials include reading the textbook, analyzing problems, and doing lecture-related activities. Data were gathered from interviews and analysis has been done qualitatively. Some implications from the finding will be discussed.

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Energy windowing using the MEDIPIX2 silicon x-ray detector

Karla Kincaid

Review of the spectrum measurements taken in March 2005 at CERN on a 50kV x-ray beam using the threshold window capabilities of the Medipix2 photon counting silicon detector and possible medical applications for the threshold window.

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***SALT: Telescope**, Instrumentation and Science Programmes*

Michael Albrow

The Southern African Large Telescope is very close to reaching "First Light". I will give a brief overview of the telescope, its instrumental capabilities and some of our first scientific projects.

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Investigation and numerical comparison of resonance along the East coast of New Zealand using GEOWAVE V1.0

Beth Geraghty

Preliminary results of simulations designed to highlight the applicability of the nonlinear, extended Boussinesq model GEOWAVE V1.0 to far field studies, are presented. The geophysical context of the experiments focuses on the identification of areas of wave amplification along the eastern coast of New Zealand resulting from far-field, westward propagating and sinusoidal wave train consisting of three-wavelengths of either 60 or 75 minute periods.

This initial waveform was chosen in order to compare with results from the nonlinear, shallow water, finite difference model, presented in Walters (2002). Results from 2 Case Studies are presented. These case studies were designed to highlight: 1) the relative success of GEOWAVE to capture the location of areas of wave amplification along the eastern coast of New Zealand, and 2) the effect of the addition of the extended Boussinesq terms to the shallow water equations.

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Energy Transport in Quantum Percolation Models

Mike Lee

A quantum percolation model will be presented for the propagation of Frenkel excitons through spatially discrete dilute media via the Forster dipole-dipole interaction mechanism. The model predicts a qualitative change in the nature of energy transport with respect to the density of the medium.

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Atomic Cluster Nanodevices

Rene Reichel (J.G. partridge, A. Ayesh, S.A. Brown)

Atomic clusters exhibit a range of useful electronic, chemical and magnetic properties and show a great potential as building blocks for nanoscale devices. In particular, bismuth clusters are very interesting because of the unusual properties of this semimetal. It shows great potential to exhibit quantum behaviour even at room temperature. In order to classify nanoscale devices for their electrical properties and to study the conductance effects of cluster assembled devices, experiments have to be repeatable and for testing purposes controllable. Both can be achieved with the introduction of a test layout, which controllably integrates cluster-assembled device structures into lithographically defined electrical contacts.

We present a method of forming cluster-assembled nanoscale devices integrated into lithographically defined electrical contacts to study the conductance effects in such devices. Bismuth clusters, produced from an inert gas aggregation source, are deposited in situ into pre-formed patterns (by e-beam lithography) in HMW PMMA on top of electrical contacts. The clusters will self assemble into the preformed patterns resulting in a controllable method of cluster-assembly thus allowing contact to a very few clusters at a time. No lift-off process is needed after the cluster deposition.

Measurements of atomic cluster nanodevices are performed in situ and include onset of conduction, pre- and post-deposition IV characteristics, temperature-dependent resistance, gate voltage sweeps and temperature-dependent resistance measurements.

Measurements have shown nonlinear IV's for nanoscale devices suggesting tunnelling conductance. Current-time traces for onset for percolating samples show interesting features shortly before an onset of conduction occurs. The effect of a gate voltage has been investigated.

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Convective Gravity Waves at Mid-Latitudes

Adrian Mc Donald (Gina Choi, Sung Chul Lee and Davey Hooper)

This study presents a case study which includes regions of large rapidly varying vertical velocities observed by a VHF wind-profiler at Aberystwyth (52.4 $\pm$ N, 4.1 $\pm$ W). Analysis indicates that this region is associated with gravity waves above the tropopause level and simultaneous regions of convective activity below the tropopause level. This case study suggests that convective activity can be identified by finding periods of large uncertainties on the derived velocities. These regions are hypothesized to be related to regions of small-scale inhomogeneity in the wind field. The presence of convection is also confirmed by radiosonde and UKMO Met Office mesoscale model data that shows evidence of convection in the vicinity of Aberystwyth during the case study.

Examination suggests that the large vertical velocity fluctuations above these convective regions are short period gravity wave packets as expected from theory. In addition the vertical momentum flux associated with the gravity waves also displays the pattern of reversal observed in previous studies.

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Stable gravastars with generalized exteriors

Ben Carter

Gravastars are solutions to Einstein’s equations which mimic ‘black hole’ exterior geometry, without the presence of horizons. New spherically symmetric gravastar solutions, stable to radial perturbations, are found by utilizing the construction of Visser and Wiltshire. The solutions possess an anti—de Sitter or de Sitter interior and a Schwarzschild—(anti)—de Sitter or Reissner—Nordström exterior. We find a wide range of parameters which allow stable gravastar solutions, and present the different qualitative behaviours of the equation of state for the thin shell of the gravastar for these parameters.

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Searching for Dark Matter with Neutrino Telescopes

Anthony Gomez

There is compelling evidence to support the existence of dark matter (unseen matter in the Universe whose interactions appear to be mainly gravitational). Many independent observations suggest there is at least five times more dark matter in the Universe than ordinary baryonic matter.

At present the Standard Model of particle physics does not provide a viable dark matter candidate forcing particle physicists to look beyond the Standard Model. Two popular extensions include *supersymmetry* and *large extra dimension* models.

Dark matter particle candidates by their nature are weakly interacting and therefore difficult to detect. Neutrino telescopes, in particular large volume Cerenkov detectors, provide an ideal opportunity to indirectly detect dark matter particles and constrain the parameter space which describes them.

In this talk I will give a review of dark matter candidates and discuss the possibility of their detection in large neutrino telescopes.

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Atomic Diffusion of Bismuth

David McCarthy

When small amounts of material are deposited onto automatically flat surfaces, the subsequent diffusion processes can result in the formation of interesting and potentially useful structures. Via manipulation of the growth conditions, islands with particular shapes and sizes may be encouraged to glow. An analysis of the islands themselves, their number density, crystalline structure and orientation relative to the substrate, can give information on the energy barriers influencing and atoms diffusion. This talk will give a brief description of the atomic deposition apparatus used here in the department, as well as some early results for bismuth atoms deposited onto mica substrates. These initial results will be compared with work already done by Shelley Scott and with research from overseas.

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Results from a campaign on two gamma Doradus variables

Duncan Wright

I will comment on the preliminary results from a multisite photometric and spectroscopic campaign on two gamma Doradus variables, QW Puppis and HD139095. Also, the methods intended to be used for further investigation of this data will be discussed.

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Category Theory and the Scientific Method

Ewan Orr

Category theory is the semantics of mathematics. It contains the essential ideas which are common to all branches of mathematics. It is self referencing and constructive. For these reasons, category theory is fast becoming the theoretical foundation of both computer science and linguistics. My thesis is that categories can describe the language of science and this will provide insight into algorithmic approaches to generating scientific theories. Algorithmic generations f scientific theories is an active area – usually presented as part of ‘machine learning’ research. Already a new scientific law has been *discovered by the PROLOG computer program Golem. Given a sequence of amino acids, this important new law restricts the possible geometries of the resulting protein. I’m sure that the category theorists will help such advances seed a revolution!

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Equipment for Radiation Dosimetry of Irregular Shapes

Jonathan Griffin

A novel dosimetry technique for radiation therapy is being investigated.

Combining the advantages of both water tank and solid phantom dosimetry, a hollow thin walled shell or mask is filled with water and then raised above the natural water surface to produce a volume of water with the desired irregular shape.

An overview of this ongoing work will be presented, concentrating on the equipment that is being designed and constructed for the project.

Several possible applications are foreseen for the water tank dosimetry system. The most extensively investigated application so far is verification of custom bolus designs for superficial electron beam therapy.

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Towards inflation in string cosmologies

Ishwaree Neupane

The past few years have witnessed significant progress in the building of inflation models within string/M theory. It may be quite nontrivial to obtain a natural realization of inflationary theory in the context of the ever changing theory of all fundamental interactions. In this talk I will briefly review the present status of inflationary cosmology, including recent attempts to implement inflation in the context of string/M theory.

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Heavy Element Abundances in AGB Stars of 47 Tucane

Elizabeth Wylie

This research investigates heavy element abundances in Asymptotic Giant Branch (AGB) stars in a globular cluster environment. High resolution spectroscopy was taken of seven known AGB stars in 47 Tucanae and spectrum synthesis undertaken to obtain abundances for s-process elements. Contrary to theoretical predictions, preliminary result show that these AGB stars do show s-process enhancements relative to previously studies Red Giant Branch (RGB) stars in the same cluster

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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. Speakers with slides,
   It is **your** responsibility to load them into the projector.

3. A computer and data projector will be available. Please load your presentations onto it before the start of your session.

RESEARCH STUDENT TALKS

The B.G. Wybourne prize will be awarded for the best research student talk while the Department awards a prize for the second best research student talk.

Last year the B G Wybourne Prize went to Liz Wylie. The Department prize was shared between Ben Carter and Judy Mohr.

LUNCH

Participants who are not members of the Staff Club are welcome to be the (paying) guests of those who are going for lunch at the Staff Club.

AFTER CONFERENCE GATHERING

You are all welcome to attend the end-of-conference gathering and prize-giving to be held Physics and Astronomy Room 701, 5.00-6.00 p.m. on Friday 2nd September, 5-6pm.