DEPARTMENT OF PHYSICS & ASTRONOMY
College of Science

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

22nd DEPARTMENTAL CONFERENCE

Wednesday 30th and Thursday 31st August 2006
MATH031

Programme

Wednesday 30 August

Session 1	**Chairperson:**	**Michael Albrow**
9.15 – 9:25	*Welcome*	Phil Butler
9.25 – 9.40	Malcolm Cropp	Time Series Photometry of the Globular Cluster NGC 7099
9.40 – 9.55	Rene Reichel	Nanotechnology and How!
9.55 – 10:10	Michael Chappell	PhD in *What* ?
10.10 - 10.25	Jenni Adams	Astroparticle research update
10.25 – 10.40	Duncan Wright	Analysis tools for non-radially pulsating objects

10.40 – 10.55 MORNING REFRESHMENTS - MATH101

Session 2	**Chairperson:**	**Michael Chappell**
10.55 – 11.10	Phil Butler	Why I am enthused about Clifford geometry
11.10 – 11.25	Anas Abdulhamid Sedayo	Improve the contrast of angiogram image by using the Medipix detector based on Monte Carlo simulation
11.25 - 11.40	Adam Gillard	Geometry in Quantum Mechanics
11.40 – 11.55	Dharamvir Ahluwalia-Khalilova	Spacetime to spacetime-momentum
11.55 – 12.10	David McCarthy	Modeling Atomic Diffusion
12.10 – 12.25	Mike Reid	Course and Teaching Developments for 2007/2008

12.25 – 1.45 LUNCH

Session 3	**Chairperson:**	**Clare Worley**
1.45 – 2.00	Martin Henseler	Magnetic effects in ZnO
2.00 – 2.15	Raphael Nolden	Identification of Bacteria using Fluorescence
2.15 - 2.30	Ahmad Ayesh	Experimental and simulational study of the operation conditions for a high transmission mass filter
2.30 – 2.45	Bob Hurst	Measurement of a Super-Frame-Dragging effect
2.45 – 3.00	Niels Gresnigt	A Clifford algebra approach to the Stabilized Poincare-Heisenberg Algebra

3.00 – 3.15	Peter Cottrell	SALT: Telescope and instrument commissioning
3.15 – 3.30	Stephanie Hickford	Simulation of events in IceCube

3.30 – 3.45 AFTERNOON REFRESHMENTS – MATH101

Session 4	**Chairperson:**	**Ewan Orr**
3.45 – 4.00	Orlon Petterson	Evolving nature of departmental computing
4.00 – 4.15	Richard Graham	Radial gain distribution in a Helium-Neon laser
4.15 – 4.30	Jon-Paul Wells	Ring Lasers and Applications
4.30 – 4.45	Jenny Williams	NZCMS – establishing a unified NZ presence at CERN
4.45 – 5.00	Ben Leith	Does acceleration of the Universe arise from higher-order curvature

END OF DAY ONE

Thursday 31 August

Session 5	**Chairperson:**	**Ahmad Ayesh**
9.00 – 9.15	Rueben Mendeslberg	Semiconductor Quantum Dots
9.15 – 9.30	Clare Worley	s-process element abundances throughout the CMD of 47 Tuc
9.30 – 9.45	Mike Lee	A High Precision Monte Carlo Technique
9.45 –10.00	Joanna Wells	Improvement of Techniques used to determine the Region of Origin in Bloodstain Pattern Analysis
10.00 – 10.15	Ewan Orr	Attempting to Automate Scientific Discovery
10.15 – 10.30	Kathleen P Monahan	All Mixed Up: Using entropy to examine the mixed Region between the troposphere and the stratosphere.
10.30 – 10.45	Mona Mostafavi	Iran and Astronomy in Iran

10.45 – 11.00 MORNING REFRESHMENTS – MATH101

Session 6	**Chairperson:**	**Veronica Cahyadi**
11.00 – 11.15	Alan Bell	The Beam Scintillation Counter – The Sacrificial Lamb of CERN's CMS experiment
11.15 – 11.30	Petra Huck	An improved measure of ozone depletion in the Antarctic stratosphere
11.30 – 11.45	Musaed Almalki	Gadolinium Concentration Analysis in Brain Phantom by X-Ray Fluorescence
11.45 –12.00	Kahae Han	Analysis of WIMPs Dark Matter from the Sun using AMANDA/IceCube Data
12.00 – 12.15	Michael Albrow	Carbon and Nitrogen in the old globular clusters of M31
12.15 – 12.30	Scot Choi	Laser Spectroscopy of interface Eu^{3+} center in CaF_2:Eu-CaF_2 Superlattices

12.30 – 1.30 LUNCH

Session 7	**Chairperson:**	**Petra Huck**
1.30 – 1.45	Paul Miller	Optical characterisation of ZnO thin film.

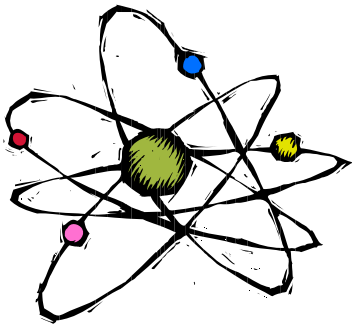
1.45 – 2.00	Andreas Baumgaertner	All you ever wanted to know about the two-day Wave
2.00 – 2.15	Mita Gopal	Multi Object Spectroscopy with SALT
2.15 – 2.30	Lou Reinisch	Principal Component Analysis of Fluorescence Changes upon Growth Conditions and Washing of Pseudomonas aeruginosa
2.30 – 2.45	Judy Mohr	Atmospheric Turbulence Profiling at Mount John

2.45 – 3.00 AFTERNOON REFRESHMENTS – MATH101

Session 8	**Chairperson:**	**Phil Butler**
3.00 – 3.15	David Mackenzie	Sticking and bouncing: are clusters like small balls?
3.15 – 3.30	Veronica Miller	Methods for detecting extra-solar planetary transits
3.30 – 3.45	Veronica Cahyadi	Empowering instructors to improve teaching
3.45 - 4.00	Ian Farrell	Pulsed Laser Deposition

CONFERENCE CLOSES

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



ABSTRACTS

Wednesday 30 August

Time Series Photometry of the Globular Cluster NGC 7099

Malcolm Cropp

An update of the work analysing time-series photometry of the globular cluster NGC 7099

Nanotechnology and How!

Rene Reichel

Nanotechnology is probably one of the greatest 'buzz words' at the moment. Researchers are doing it, governments and agencies are funding it and industries do want it.

But what is this 'hype' actually all about?

Physicists know that electrons do have wavelike properties which govern fundamental properties of materials. In addition, it is known that surface states of solid state material differ from those of the bulk material.

It has been shown that Manipulations on the nanometer scale can indeed influence the wavelike properties of electrons and surface properties do become important for smaller and smaller particles. This promises tailor made materials which of course is highly interesting to industry.

And not only physicists are taking part in this revolution. Combining the advances of Nanotechnology and Biotechnology for instance will see major advances in Medicine. Chemists will be able to create new drugs without side effects. Computers will be faster, smaller and even do what you want them to do.

PhD in What ?

Michael Chappell

MRI brain imaging is a multi-disciplinary project. I will outline this with reference to my interactions with a neurologist, radiologist, psychologist, statistician and physicists. In discussing my own work I will concentrate on generic tools that can be used in many fields, showing how they can be applied to imaging. These include multivariate analysis, discriminant analysis, corrections for multiple comparisons, and fractal geometry.

Astroparticle research update

Jenni Adams

I'll report on progress made in my research while on study leave. My time has been spent on various research tasks related to neutrino astronomy, from simulations of light propagation in ice to gamma ray burst phenomenology.

Analysis tools for non-radially pulsating objects

Duncan Wright

I will discuss the current state (and the use) of a set of tools being developed for the analysis of spectra of varying types of non-radially pulsating objects. This set includes moment analysis and calculations of the phase across the profile as well as basic binary profile fitting for determination of orbital characteristics and rotational velocity (V sin *i*) measurement. Recently the ability to calculate cross-correlation profiles using either specified or synthesized line lists has been added, all implemented in MATLAB. A number of observations of gamma Doradus type candidate stars are currently being used to test these tools.

Why I am enthused about Clifford geometry

Professor Phil Butler

What are points, lines and other geometric concepts? How do they relate to vector spaces and vector products? A first principles approach following Hamilton (~1850) and Clifford (~1875) indicates that the usual vector and tensor mathematics misses some key physics. I will present an overview of my motivations, and some recent successes of Clifford's approach. (See also the talks by Gillard and Gresnight).

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

Anas Abdulhamid Sedayo

An angiogram is a medical imaging technique. X-ray fluoroscopy is used to take an image of the body's blood vessels. To create the image the patient is injected with a contrast material. The technique works by acquiring a radiographic image of the patient before the injection. Images are acquired during and after the injection of the contrast material. If the patient is not moving during the procedure the subtracted image provides details of the vessel anatomy. The subtracted image is not clear if the patient moves between the images.

The study purpose to improve image quality of the angiography by using the Medipix detector designed by CERN and simulates the x-ray, vessel and Medipix detector by using the Monte Carlo code.

Geometry in Quantum Mechanics

Adam Gillard

For a long time the laws of physics has been thought of as arising from more than just the geometry of spacetime. The geometric algebra is developed from purely geometric considerations but it is finding applications and geometric interpretations in areas of physics that usually were thought of as not having underlying geometry governing the behaviour. In this talk I will talk about the example of Hestenes "Zitterbewegung interpretation" of quantum mechanics.

This is one such example which has led me to explore the extent to which geometry is central to the laws of physics. It seems to me that it is more important than most people think.

Spacetime to spacetime-momentum

Dharamvir Ahluwalia-Khalilova

I'll briefly summarise my evolving thoughts on quantum implications for spacetime, and if time permits, present an invitation to look at an unexpected theoretical discovery of matter beyond that of the standard model of particle physics.

Modeling Atomic Diffusion

David McCarthy

A number of techniques are used to model atomic behaviour in nanoscale systems. The different techniques each have their advantages and disadvantages, but theoretically should predict similar results given the same diffusion scenario. I'll present an overview of the some of the most common techniques used, and a basic prescription for modeling atomic diffusion using KMC simulations.

Course and Teaching Developments for 2007/2008.

Mike Reid

There are two areas of teaching that the Department could usefully discuss. Input from students would be particularly helpful.

1. First-year courses. Issues include choice of text books (which author, calculus or not?), style of presentations, tutorials and assessment. I have suggested moving to using Serway's books rather than Halliday. The non-calculus book for PHYS111 (and possibly PHYS106) in 2007 and the calculus-based version for PHYS113 and PHYS114 in 2008. This should be little more disruptive than an edition change.
2. Fourth-year courses. Our 400-level courses are out of step with most other departments. Most departments have 4 or 8 courses being a full time load, whereas we have 6. Should we move to 8 courses in 2008? This would be in line with the Math department and would make much more sense for courses that are presented at both 300 and 400 levels.

Magnetic effects in ZnO

Martin Henseler

ZnO has caught the imagination of material researchers during several periods this century, and is currently one of the most researched oxide semiconductors. Contributing to the growing interest in the material is its theoretically predicted potential in the field of spintronics.

I will outline the ongoing research and ideas behind dilute magnetic semiconductors, and the possible role that ZnO could play in reshaping the way computers work.

Identification of Bacteria using Fluorescence

Raphael Nolden

Fluorescence spectroscopy has been investigated for several years at the University of Canterbury to help to identify bacterial spores. Spores form during optimal conditions and allow th4e bacteria to survive through very harsh conditions. In the spore state bacteria can survive for decades, possibly even centuries, without any food or water. Furthermore they are very resistant to damage and can survive heat, UV light and exposure to alcohol. Until recently detection has been difficult because their

appearance is very similar to harmless powders. A recent fluorescence protocol has greatly simplified the process of identifying spores. We have been investigating this protocol to determine its limitation. In particular, we are determining the minimum number of spores that can be detected, the linearity of the response with the number of spores, and amount of bleaching of the sample the fluorescence measurement causes. The spore detector has applications in the protection against bioterrorism and in food quality. This work will be discussed in relationship to the applications of the technology.

Experimental and simulational study of the operation conditions for a high transmission mass filter

Ahmad Ayesh

[Ahmad Ayesh[1,2], Simon Brown[1,2,3], Andreas Lassesson[3], Jim Partridge[1,2], and René Reichel[1,2]]

[1]The MacDiarmid Institute for Advanced Materials and Nanotechnology, New Zealand
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[3]Nano Cluster Devices Ltd., Christchurch, New Zealand

Nanoclusters have received great attention recently because of their fundamental physics importance and their applications in catalysts and nanotechnology. Cluster properties are size dependant, and thus can be tuned by selecting the size of the produced cluster. To access these size dependant properties in technological applications, it is desirable to mass-select clusters before deposition. In this study we discuss the operation conditions of a high transmission mass filter. The mass filter consists of two pairs of parallel plates and operates on the time of flight principle. The high transmission of this mass filter makes it suitable to be used for device applications.

Measurement of a Super-Frame-Dragging effect.

Bob Hurst

Tajmar et al (http://arxiv.org/abs/gr-qc/0603033) have reported a Lense-Thirring (frame-dragging) effect from a rotating superconducting mass that is approximately 30 orders of magnitude greater than predicted by conventional theory. It brings the effect to a strength where it should be readily detectable by a ring laser gyroscope. We are currently building an experiment to attempt confirmation of this remarkable reported measurement. A superconducting lead mass will be rotated, and any effect on a nearby laser gyro will be measured.

A Clifford algebra approach to the Stabilized Poincare-Heisenberg Algebra

Neils Gresnigt

The stabilized Poincare-Heisenberg algebra (SPHA) is the Lie algebra of quantum relativistic kinematics generated by 15 generators. It is obtained from imposing stability conditions on the Lie algebras of quantum mechanics (Heisenberg algebra) and relativity (Poincare algebra). In this talk I will discuss how a 15 dimensional subalgebra of the 16 dimensional Clifford algebra CL(1,3) can be used to generate the SPHA. We will see that Clifford algebra path to the SPHA is more straightforward than the traditional Lie deformation path and furthermore that the Clifford algebra path provides us with some new insight into the underlying physical principles.

SALT: Telescope and instrument commissioning

Peter Cottrell

"First light" of the Southern African Large Telescope (SALT) was declared on September 1, 2005 and the first scientific programmes have now begun. This talk will show aspects of the telescope construction and the commissioning of it and the first-light instruments: the imaging camera, SALTICAM, and the prime focus imaging spectrograph, the Robert Stobie Spectrograph. The key aspects of these prime focus instruments will be described, as well as the first scientific results. These instruments operate in the 320 - 900 nm region, and will provide capabilities for broad and narrow band imaging, long-slit and multi-object spectroscopy, spectropolarimetry and Fabry-Perot imaging spectroscopy, as well as time resolved studies (~10 Hz). Finally, the design and status of the fiber-fed high resolution échelle spectrograph, SALTHRS, will be presented.

Simulation of events in IceCube

Stephanie Hickford

IceCube is a large neutrino detector situated at the South Pole. It is designed to detect astrophysical neutrinos. Some neutrino interactions will induce cascades which can be detected by IceCube. Pythia and GEANT 4 are two programs that we use to simulate the cascades that occur in the detector.

GEANT 4 does not currently have the tools to model tau events in the ice. It has been suggested that this can be modelled by the Cerenkov distributions from muon events. Simulation for both cases has been run and compared.

Pythia has been used to look at pions and kaons in hadronic cascades produced when an electron neutrino interacts in the ice. These events could face a muon event and create unwanted background. However, these pion and kaon events may be turned to our advantage to give directional information about the incoming particle.

Evolving nature of departmental computing

Orlon Petterson

I will give a brief overview of the current and future trends of departmental computing. I'd like to also get feedback on requirements for the near future.

Radial gain distribution in a Helium-Neon laser

Richard Graham

Two major problems that we are currently facing with the next generation of very large ring lasers stem from a lack of understanding of the laser gain process (particularly as the gas becomes contaminated) and a lack of data relating to the extent of aberration on the super mirror surfaces.

This talk will summarise progress on construction of an apparatus to measure the profile of laser gain across the radius of gain tube to an accuracy of around 20 ppm, data from which is intended to be used to improve models of the laser gain process.

A new method for determining the effect of mirror aberrations on transverse mode structure will also be mentioned.

Ring Lasers and Applications

Jon-Paul Wells

The success of the ring laser project has been built upon pioneering advances (by the Canterbury group and their collaborators) in laser physics itself. Many possible applications have been proposed over the years but so far, the winner by a country mile is geophysics and seismology. I plan to outline the scope of the project as I see it right now and briefly discuss the use of active ring interferometry for investigations of magneto-chirality in liquids.

NZCMS – establishing a unified NZ presence at CERN

Jenny Williams

In 2007, the Large Hadron Collider will start colliding proton beams, and New Zealand physicists will be part of a 2000-person collaboration seeking the Higgs boson, SuperSymmetry, an improved understanding of the Standard Model of Particle Physics and any other new physics which might be found in LHC interactions. As well as particle physics analysis and hardware development, NZCMS is involved in medical physics imaging research using technology spun off from the CERN detectors.

I will give a brief overview of the LHC and the Compact Muon Solenoid experiment, and outline NZ's involvement in CERN programmes to date. Finally, I'll summarize our plans for future participation.

Does acceleration of the Universe arise from higher-order curvature

Ben Leith

Many attempts are currently being made to explain the observed late-time acceleration of the universe. String theory is a widely studied theory in particle physics which indicates that scalar fields and higher order curvature terms may have an effect on the observed universe; we look at whether this can help explain the observed late-time acceleration.

End of Day One

Thursday 31 August

Semiconductor Quantum Dots

Rueben Mendeslberg

Low dimensional semiconductors form the basis of much of today's important technology. These systems have strange and interesting properties that vary significantly from their bulk counterparts. At 0-D, the quantum dot (QD) is perhaps the strangest and most useful of these quantum mechanical semiconductor systems.

This talk will outline some past and present fabrication techniques and will include results from some initial QD growths by pulsed laser deposition.

Physical properties of QD systems will also be discussed such as quantum confinement effects, optical phenomena, and Landau levels in a magnetic field.

I will end with a discussion of QD devices; both in use today and those of future technologies.

s-process element abundances throughout the CMD of 47 Tuc

Clare Worley

A recent study by Wylie et al (2006) has revealed that s-process element abundances are enhanced relative to iron in both red giant branch (RGB) and asymptotic giant branch (AGB) stars of 47 Tuc. While it could be argued that the s-process element abundance results in the AGB stars were the result of internal nucleosynthesis and dredge-up of this processed material, it is thought that the luminosity at which this is observed is too low for currently accepted models of third dredge-up. Consequently, there is a need to undertake more detailed investigations of the abundances throughout the colour-magnitude diagram of 47 Tuc to investigate the possibility that the s-process element abundance enhancements in the RGB and AGB stars are intrinsic to the cluster. This will be explored by investigating the visibility of various s-process element lines in synthetic spectra of giant and dwarf stars throughout the CMD. This study will motivate our observing programme using the multi-object spectroscopy mode of the Robert Stobie Spectrograph (formerly know as the Prime Focus Imaging Spectrograph) on the Southern African Large Telescope.

A High Precision Monte Carlo Technique

Mike Lee

A new Monte Carlo technique for the lattice will be presented. At its heart lies a suite of very efficient deterministic algorithms for performing operations upon graphs. The method is particularly well suited to making high precision measurements in the critical region of percolation systems.

Improvement of Techniques used to determine the Region of Origin in Bloodstain Pattern Analysis

Joanna Wells

The estimation of the location at which an impact event took place from its resultant impact bloodstain pattern can be a significant investigative issue in the reconstruction of a crime scene. The selection of bloodstains from an impact pattern is fundamental for an accurate result. Currently there is no consistently used protocol for bloodstain selection. This research aims to improve the accuracy of a region of origin determination by investigating suitable criteria to base the selection of bloodstains on. Findings of the research will be discussed along with upcoming experiments.

Attempting to Automate Scientific Discovery

Ewan Orr

In this talk I intend to give a naïve and incomplete introduction to some of the methods that may be employed to automate scientific discovery. I will discuss some basic approaches that have been attempted, and some methods that may prove useful. With luck, we may touch on topics such as knowledge representation, Kolmogorov Complexity and Machine Learning.

All Mixed Up: Using entropy to examine the mixed region between the troposphere and the stratosphere

Kathleen P Monahan

The troposphere (the region of the atmosphere between the Earth's surface and 15 km altitude) and the stratosphere (the region of the atmosphere between 15 and 50 km altitude) have distinctly different chemical composition. For example, tropospheric air has a high water vapour mixing ratio and low ozone mixing ratio, whereas stratospheric air has a low water vapour mixing ratio and high ozone mixing ratio. These contrasting properties act as a signature to determine the origin of air parcels and to identify mixing between these regions. The boundary between these two regions is called the tropopause, and acts as a barrier to vertical transport. However it is possible for air to become mixed in this region, resulting in a transitional layer with both stratospheric and tropospheric chemical composition.

This study describes the concept of Entropy to provide a quantitative measure of mixing (or disorder) in the atmosphere. By using an entropy measure on ozonesonde (balloon-borne measurement devices) measurements, it is possible to quantify the location and size of the chemically mixed region at the boundary between the stratosphere and troposphere. Entropy is also shown to be highly correlated with the thickness of the mixed region. This method is also extended to a global chemical composition data set from the Atmospheric Infrared Sounder (AIRS) instrument on the Aqua satellite and regions of mixing are defined.

Iran and Astronomy in Iran

Mona Mostafavi

The Beam Scintillaltion Counter – The Sacrificial Lamb of CERN's CMS experiment

Alan Bell

During the months of Feb-March and July-August of this year, I was invited to go to CERN, arguably the best known physics research institution in the world. Here we are building the Beam Scintillation Counter, a sacrificial collection of tiles and PMT tubes which will aid in the early stages of the beam-running. Here I present some of the design work involved, the problems solved and what it means for New Zealand to be involved in experiments at CERN.

An improved measure of ozone depletion in the Antarctic stratosphere

Petra Huck

Antarctic ozone depletion is commonly quantified as ozone mass deficit and ozone hole area. However, as currently defined, neither of these measures capture the true extent of the chemical loss of ozone within the Antarctic vortex. Therefore, new definitions of these indices have been developed by replacing the 220 Dobson Unit (DU) value currently used as the threshold for ozone depletion with a new background ozone value based on pre-1980 measurements (unperturbed background). Comparing vortex average total ozone loss (defined using the new parameters) with partial column accumulated chemical ozone loss calculated with the tracer-tracer correlation method demonstrates the improvement of these indices.

Furthermore, earlier analysis of inter-annual variability in ozone depletion are updated to provide an estimate of the extent to which mid-latitude planetary waves and polar temperatures control the severity of Antarctic ozone depletion.

Gadolinium Concentration Analysis in Brain Phantom by X-Ray Fluorescence

Musaed Almalki

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 form (n, γ) 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 the tumour and only insignificant dose goes to the 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 that x-ray fluorescence intensity can be correlated to known gadolinium concentrations in a phantom brain tumour. Radiation from 1 Ci (37 GBq) Americium-241 is allowed to be incident on the phantom tumor. Following absorption of radiation by gadolinium atoms, characteristic x-rays are emitted and measured by detector. Reabsorption and scattering effects are quantified.

Analysis of WIMPs Dark Matter from the Sun using AMANDA/IceCube Data

Kahae Han

I present some background and introduction to the method used in analyzing data taken by the AMANDA/IceCube Neutrino Detector in the South Pole for the detection of Kaluza-Klein Weakly Interacting Massive Particles, one of the candidates of Dark Matter.

Carbon and Nitrogen in the old globular clusters of M31
Michael Albrow

Globular star clusters are our best tracers of the early chemical evolution of large galaxies. For galaxies more distant than the Milky Way satellites, individual stars in clusters cannot be resolved and we can only observe their combined light output. The interpretation of integrated light spectra is however non-trivial. Recent papers have reported that the old globular clusters in Andromeda (M31) have a large excess of nitrogen compared to their Milky Way counterparts. I will show that in fact (i) the M31 clusters are more chemically evolved than in our galaxy, (ii) their nitrogen levels are relatively normal and (iii) carbon is strongly enhanced.

Laser Spectroscopy of interface Eu^{3+} center in CaF_2:Eu-CaF_2 Superlattices

Joon Koo Choi (Scott)

Laser spectroscopy has been applied to study Eu^{3+} center energy levels involved in $^7F_0 \rightarrow {}^5D_1$ and $^5D_0 \rightarrow {}^7F_1$ transitions in CdF_2-CaF_2:Eu Superlattices (SLs). “Remote” and “interface” centers have been revealed. The energy level structure of the distant electron-compensator centers (remote) in the SLs appeared to be close to that of cubic centers in CaF_2 bulk crystals. However, the interface center is quite different from the remote center. It has shown shifted and splitted energy levels and stronger temperature dependence. It is also shown that these features of the interface center are connected with trapped electron which is located near the CdF_2 interface. The electron trapping energy is estimated to be about 30 meV.

Optical characterisation of ZnO thin film

Paul Miller

Zinc Oxide is a wide bandgap semiconductor with many interesting properties. It has a bandgap near 3.3eV and a strong exciton binding energy of 60meV making it an ideal candidate for optical systems in the UV. It is also highly transparent to the optical part of the solar spectrum, has a bandgap tuneable by alloying, is non toxic and can be grown as a low resistivity semiconductor, which makes it particularly useful for manufacturing cheap efficient solar cells.

My objective has been to produce a comprehensive study of the optical and electronic properties of zinc oxide thin films that have been prepared by a number of different methods and under a variety of growth conditions. I will present results on the effects of annealing temperature on ZnO films grown by DC sputtering on various substrates.

All you ever want to know about the two-day wave

Andreas Baumgaertner

The two-day wave is an exciting type of planetary wave in the stratosphere and mesosphere. It regularly dominates the wind field in different regions of the atmosphere all over the globe. Satellite and radar observations can be combined to create a detailed picture of this wave. This presentation will show you when and where to find it, and how it is generated. In particular, I will show results from the MLS instrument onboard the Aura satellite, SABER measurements onboard TIMED and observations from our department’s radar at Scott Base.

Multi Object Spectroscopy with SALT

Mita Gopal

I recently spent a month and a half in South Africa working to obtain the first multi-object spectra (MOS) observations using SALT. I will discuss the work I did at SALT and how I hope to use the MOS observation mode in my study of anamolous stellar populations in the globular cluster Omega Centauri.

Principal Component Analysis of Fluorescence Changes upon Growth Conditions and Washing of Pseudomonas aeruginosa

Lou Reinisch

We have investigated the autofluorescence spectra of *Pseudomonas aeruginosa* as a function of the growth medium, the amount of washing the cells received and the growth phase of the bacterial cells. Using principal component analysis, we can determine the major contributions to the fluorescence spectra. We can then correlate the principal components to the variables in our study. A careful explanation of principal component analysis will be presented.

Atmospheric Turbulence Profiling at Mount John

Judy Mohr

One of the major problems in astronomical imaging is the distortion of images caused by atmospheric turbulence. As a result, the spatial and temporal resolution and the ability to detect faint objects from ground-based telescopes can be greatly reduced. Adaptive optics provides a real-time solution to compensate for distorted wavefronts.

To design an effective adaptive optics system it is imperative to have an understanding of the structure of atmospheric turbulence above a given telescope. To that end, a purpose built instrument was constructed to profile the turbulence above the telescopes at Mount John University Observatory. The relatively simple modular system utilizes an optical technique known as SCIDAR (scintillation detection and ranging) to determine the heights and strengths of the turbulent layers.

An extended series of SCIDAR data was obtained during 2005 and 2006 which illustrate the seasonal variation of the turbulent layers. In addition, these data have been used to extract temporal variations within a set of data which can be used to determine the velocity of the turbulent layers. An enhanced version of the instrument and software is being developed to provide a multi-purpose system that would be suitable for use on any telescope.

Sticking and bouncing: are clusters like small balls?

David Mackenzie

The energies and forces involved with macroscopic balls hitting surfaces will be reviewed. These will be compared with the experimental and theoretical results from cluster research.
With these things considered, it will be decided what ball is most like a large scale cluster.

Methods for detecting extra-solar planetary transits

Veronica Miller

A brief overview of the methods used to detect extra-solar planetary transits with a more in-depth look at two methods used for analysing large amounts of photometric data as being used in my PhD research looking for extra-solar planets in the Galactic plane.

Empowering instructors to improve teaching

Veronica Cahyadi

In recent decades physics education research has revealed various difficulties that many students have in learning physics. Numerous solutions have been proposed and many have been shown to lead to an improvement in student interest and understanding. However these innovations are not widely adopted by instructors (lecturers and teaching assistants). A professional development course PHYS329/425: Introduction to Physics Education Research, was set up in the department to familiarize instructors with the issues in the physics education research literature. This talk presents the rationales, approach, evaluation and benefits to the course.

Pulsed Laser Deposition

Ian Farrell

Over the course of the past year, the Pulsed Laser Deposition (PLD) system has been completed, system elements have been characterised and many materials have been grown as part of postgraduate and undergraduate research. In my talk, I will describe the work that has been done to date and outline my plan to grow superconductors with improved T_c.

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 awards a prize for the second best research student talk.

Last year the B G Wybourne Prize went to Kate Monahan and the Department prize shared by Andreas Baumgaertner and Paul Miller.

This year Ian Shaw, PVC College of Science will be giving a prize for best published paper by a student.

AFTER CONFERENCE GATHERING

You are all welcome to attend the end-of-conference gathering and prize-giving to be held at 5pm at the Staff Club.