

College of Science

Physics and Astronomy



Contents

This guide provides general information about the Department of Physics and Astronomy and the courses we offer.

For the latest course information go to www.canterbury.ac.nz/courses

This website provides detailed information on the content of and prerequisites for courses offered by other Departments.

Course enquiries, made through the Head of Department, are welcome at any time. Further information about the Department is available on our website www.phys.canterbury.ac.nz

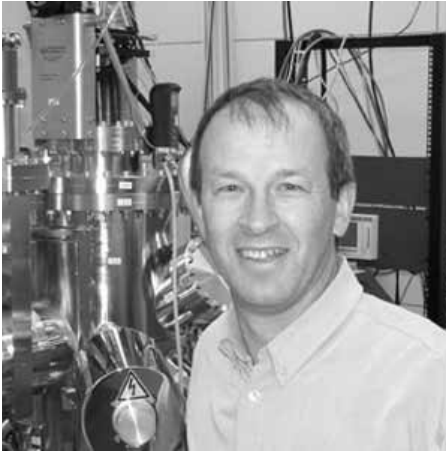
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Disclaimer

While every effort has been taken to ensure the information in this Physics and Astronomy Handbook is accurate and up-to-date, the contents are periodically subject to change and review. The University of Canterbury makes no guarantees as to the accuracy of the information contained in this publication. For formal course regulations and prescriptions, please see the University of Canterbury Calendar.

Published October 2010

Welcome



Professor Roger Reeves

Physics and Astronomy are dynamic and exciting areas of the physical sciences which have paved the way for the development of the modern, high technology society we live in today.

The pace of change can be dramatic. For example, the storage capacity of your home computer or iPod is a direct result of finding some new physics in magnetic materials. Likewise, developments in the physics of solar cells and alternative energy sources such as wind power, and hydrogen fuel cells lead the way forward for an environmentally friendly and sustainable future.

The beginnings of modern science can be dated from the early 16th century with the discoveries of Copernicus. He showed that mathematics could be used to understand the observed motions of the planets in terms of circles with the sun near the centre. Consider how far we have travelled since then or even within living memory. Plastics were a marvel to your grandparents, television and computers to your parents, and nanotechnology for many of us now. What will it be that puzzles our grandchildren? How will today's discoveries, and those of the future, affect the next century? We may not be able to predict these changes, but some things are sure - tomorrow's scientists will make more discoveries, and find uses for them.

The Physics and Astronomy Department is one of the larger departments in the College of Science and has both teaching and research programmes in diverse areas such as the physics of the earth's atmosphere, the development of the cosmos, medical physics as well as the physics of semiconductors and lasers. We want to welcome you into this wonderful world of discovery and intrigue.

In your school science courses you may have felt bewildered at the size of the subject, or you may have felt that you could never learn it all. However, after a few short years at university, you will graduate an educated professional, perhaps as a qualified scientist or an engineer. Those who continue into their fourth year of university study will be able to contribute to the research programmes of the department and we find that many people enjoy this so much that they continue on to study for a PhD, a "Doctor of Philosophy". PhD degrees are internationally recognised as the highest academic qualification, and anyone attaining a PhD will have become an international expert in some aspect of knowledge. Whether it's a bachelor's degree, Master's or Doctorate - our graduates are both highly regarded and in demand, nationally and internationally.

This guide provides general information about the Department of Physics and Astronomy. Go to www.canterbury.ac.nz/courses for the latest course information. This website also provides detailed information on the content of and prerequisites for courses offered by other Departments. Course enquiries, made through the Head of Department, are welcome at any time. Further information about the Department is available on the web www.phys.canterbury.ac.nz

Professor Roger Reeves
Head of Department

What skills will I gain?

When starting a degree the first question in many students' minds is "what job will I have at the end?" Nowadays the nature of jobs is continually changing, and a much more appropriate question is "what skills will I have at the end?"

A degree in Physics or Astronomy will give you valued skills in solving problems from first principles, especially those involving advanced technology, data analysis and modelling as well as high level computer literacy which will make you a highly adaptable asset to many employers. Whilst most scientists do not pursue their careers for monetary gain explicitly, it is worth noting that graduates in physics and astronomy have amongst the highest starting salaries of any profession.

Physical scientists are keen to understand how things work. They explore and identify the basic principles in order to understand them well enough to predict how something will behave. No matter what the research area or the level of study, the emphasis is on careful observation and logical thought in an attempt to solve the problem in question. These are the transferable skills that are universally applicable to a wide range of occupations.

It's true you will find some science graduates working in laboratories, wearing white coats and looking like the stereotypical scientist from the movies. But mostly you will find them in totally unexpected places, eg, running IT companies, trading stocks on Wall Street, in hospitals, secondary industries such as manufacturing or teaching in secondary schools.

Over the past few years the CEO's of Telstra and of NZ Post, the head of the Australian Tax Commission, and the director of research at Microsoft in the US all had PhDs in physics.

Both in New Zealand and worldwide, there is an extremely strong demand for physical scientists as industry and the global economy expands faster than the rate at which universities are producing trained graduates.

From Dubai in the United Arab Emirates to Scott Base in Antarctica, physical scientists are hard at work understanding the world around them and improving our way of life.



Mt John Observatory, Tekapo. Source: Dr Shelley Scott

Bachelor of Science (BSc) degree

The Bachelor of Science (BSc) at UC is a three-year undergraduate degree. A BSc is the standard qualification in physics or astronomy.

The design of UC's BSc degree ensures students gain a sound education in Science, with the flexibility to enable students to find out their academic strengths in the first year of study.

Degree requirements

Students enrolling from 2011 onwards

Students enrolling in the BSc from 2011 onwards must pass courses with a minimum total value of 360 points. The programme of study must include at least 225 points from above 100-level; including at least 90 points from 300-level, of which at least 60 points must be at 300-level in a single subject from the BSc schedule or from a list of specified courses approved for the major requirement.

Students completing the BSc from 2011 onwards

In order for existing students (those enrolled prior to 2010) to graduate with a BSc majoring in Physics or Astronomy, the regulations require the passing of a total of 360 points, of which at least 84 points must be at 300-level with 56 of these selected from a list of courses that define the major, eg, a single Science subject. Specific major requirements are specified in the following pages.

Students who enrolled prior to the University changing to a common course size will not be penalised. Any student whose programme of study does not match the graduating requirements exactly must make an appointment with the relevant College Student Advisor to discuss their final year programme of study, prior to enrolment (see page 26 for contact details).

First-year courses

If you have good secondary school preparation, ie, you have passed secondary school level physics and mathematics with calculus (NCEA Level 3 or equivalent), then you should take PHYS 101, PHYS 102, MATH 102 and MATH 103 in your first year of study. MATH 170 or COSC 121 are highly recommended. For an Astronomy major you should also take ASTR 112.

If you do not have a strong background in physics and mathematics with calculus then start with PHYS 111 and possibly MATH 101, depending on your background. PHYS 101 and PHYS 102 are both offered twice a year, so it is possible to 'catch up' over the summer after your first year of study. Students are strongly urged to consider taking more than the minimum requirements in order to maximise their opportunities in the future.

For those planning to advance in the physical sciences or to proceed to Electrical and Electronic Engineering, **PHYS 102 Engineering Physics B: Electromagnetism, Modern Physics and 'How Things Work'** is offered in Semester 2 and again

during the summer, with **PHYS 101 Engineering Physics A: Mechanics, Waves and Thermal Physics** as the usual prerequisite. By offering PHYS 102 in the summer semester, students who take the PHYS 111 and PHYS 101 pathway are able to complete the prerequisites required for advancement to 200-level in the following year.

Where courses involve laboratory and tutorial work, satisfactory attendance and performance in such work is required.

Details of courses at higher levels specific for the various branches of Physics or Astronomy are given on the following pages.

Academic writing assessment

To graduate with a BSc in Physics or Astronomy a candidate must pass an approved academic writing test. To enter second-year Physics courses or First Professional Engineering you are required to demonstrate that you can write clear, coherent English in a style appropriate to university-level courses and technical reports. As part of the coursework for **ENGR 101 Foundations of Engineering** an academic writing test will be given in Semester 1. Students planning to major in Physics or Astronomy will sit this test as well.

Physics and Astronomy students enrolled in Semester 2 courses will be tested separately. There will be lectures to help you prepare for this test.

Direct entry into 200-level courses

A significant number of students are given direct entry to some 200-level papers based on gaining excellent results in their Year 13 (NCEA Level 3 or Scholarship) examinations, especially in physics and mathematics with calculus. This option opens up the possibility of a wider range of more advanced courses in subsequent years.

The number and range of courses available for direct entry will depend on your interests and the pace at which you wish to proceed. A full direct entry would include PHYS 201–204, PHYS 285–286 and 200-level Mathematics. Some students may prefer to take a mixture of 100-level and 200-level courses. Direct entry is also possible into ASTR 211 and ASTR 212.

If you think such a path may be of interest to you, contact the Department before enrolment week, to discuss your options. See Contact list on page 26.



Rachel Soja

Bachelor of Science with First Class Honours conferred in 2006

Recipient of the top Achiever Doctoral Scholarship in 2007

Rachel recently completed a PhD in Physics where her research focus was on the dynamics of the solar system meteoroid population. Using meteor radar orbit data, she along with her research group looked at gravitational effects of Jupiter and radiation effects of the Sun on meteor-causing dust particles in the Solar System.

Rachel is now based at the prestigious European Space Agency (ESA) in Denmark and working on the dynamics of interplanetary dust detected by the StarDust and other spacecraft missions.

Engineering Intermediate

PHYS 101 is the required Physics course to satisfy the Intermediate requirement for most Engineering programmes. PHYS 101 can be taken in either semester. However, if you want to keep the maximum number of degree options open you should take PHYS 101 in Semester 1. You can then advance to PHYS 102 in Semester 2 and thus complete the Intermediate year with the ability to choose between an array of Engineering programmes or a Bachelor of Science in Physics. The Intermediate year is an opportunity to maintain some flexibility in your programme so that you have the widest choice possible for career paths.

Some Engineering programmes require both PHYS 101 and PHYS 102. Please check the course requirements with the College of Engineering.

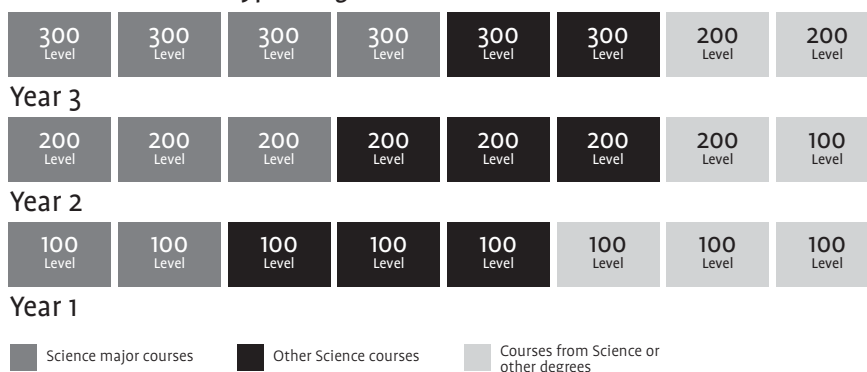
Bachelor of Science with Honours in Physics, Astronomy, Mathematical Physics or Medical Physics

The Bachelor of Science with Honours (BSc(Hons)) at the University of Canterbury is a one-year postgraduate programme designed for very able students. It is possible for excellent students to earn the Honours degree in three years by qualifying for direct entry into 200-level Physics and Mathematics courses (refer page 4).

The honours programme can be taken following the completion of a three-year bachelor's degree with very good grades. Alternatively those students who have been granted direct entry may complete in three years, which includes two years undergraduate study and one year of the honours programme. Eight courses plus a research project are required in the honours years. Course selections are specified in the Schedule to the Regulations for the BSc(Hons) and you are advised to discuss your options with the 400-level co-ordinator.

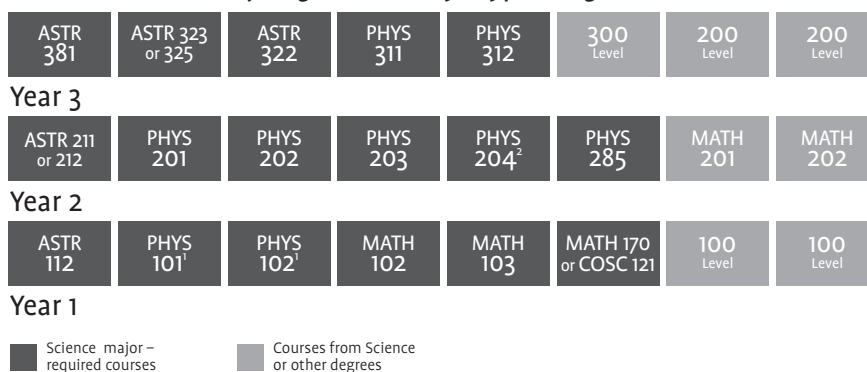
The diagrams opposite show the basic structure of a Bsc degree. It is strongly recommended that you plan your courses by referring to the 'streams' outlined on pages 6–12 of this handbook, taking special care to include all essential courses. It is also to your advantage to include highly recommended courses as well.

Bachelor of Science – typical degree structure



Each block represents a 15-point course.

Bachelor of Science majoring in Astronomy – typical degree structure

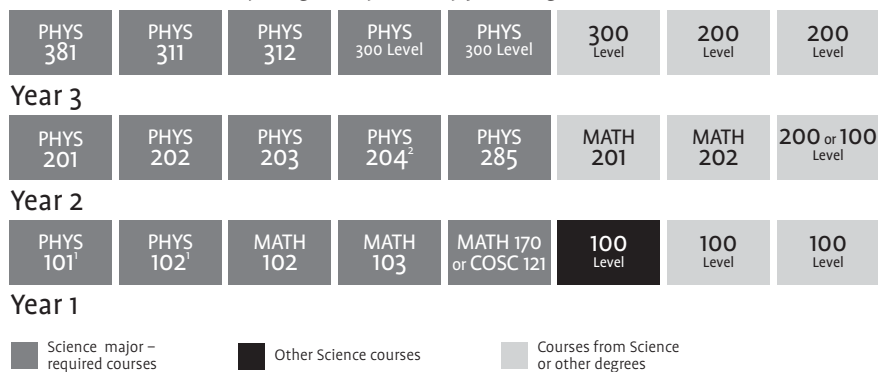


¹ PHYS 101 is offered in Semester 1 and 2, and PHYS 102 is offered in Semester 2 and as a Summer Programme.

² If PHYS 204 not taken, PHYS 310 must be included.

Each block represents a 15-point course.

Bachelor of Science majoring in Physics – typical degree structure



¹ PHYS 101 is offered in Semester 1 and 2, and PHYS 102 is offered in Semester 2 and as a Summer Programme.

² If PHYS 204 not taken, PHYS 310 must be included.

Each block represents a 15-point course.

BSc in Physics or Astronomy

The core courses required for a Bachelor of Science (BSc) in all areas of physics and astronomy are similar. On this page we list the core courses for a “generic” BSc in Physics. In the following pages we give suggestions for tailoring your course selections to meet the requirements for postgraduate study in specific “streams”.

Physics

Physics aims to understand the behaviour of matter and energy from the scale of subatomic particles to that of the Universe itself. From digital watches, fridges and cars, through computers and communication systems to water supplies and electrical systems, modern life is built using the understanding of nature that physics provides. For example, architecture, the various fields of engineering, nursing, medicine and other health professions, and agricultural science all use aspects of physics.

Career paths

Majoring in Physics equips you with strong quantitative problem solving skills. The skill set is applicable to a wide range of employment opportunities. However, many BSc students go on to higher degrees, or qualifications such as teaching.

Honours and postgraduate

After completing your BSc you may enrol in a Postgraduate Diploma of Science (PGDipSc), a Master of Science (MSc) or in the honours programme (BSc(Hons)), depending on your grades and the courses undertaken. Excellent students may do a BSc(Hons) in three years, rather than four, if they have direct entry to 200-level Physics and Mathematics. Ultimately, you could progress to a Doctor of Philosophy (PhD), which is a three to four year research degree.

Year 1

Preparation

14 credits in NCEA Level 3 physics and 14 credits in Level 3 mathematics with calculus, or PHYS 111 and possibly MATH 101, depending on your background.

PHYS 101 Engineering Physics A: Mechanics, Waves and Thermal Physics

PHYS 102 Engineering Physics B: Electromagnetism, Modern Physics and 'How Things Work'

MATH 102 Mathematics 1A

MATH 103 Mathematics 1B

MATH 170 Mathematical Modelling and Computation

or

COSC 121 Introduction to Computer Programming

Year 2

PHYS 201 Waves and Optics

PHYS 202 Electromagnetism and Mechanics

PHYS 203 Relativistic and Quantum Physics

PHYS 204 Thermal, Statistical and Particle Physics

PHYS 285 Expérimental Physics

MATH 201 and 15 additional points from 200 level MATHS.

MATH 202 and 203 are recommended.

Recommended

PHYS 286 Analogue and Digital Electronics

MATH 270 Mathematical Modelling and Computation 2

For Honours

45 points of 200-level MATH courses

Year 3

PHYS 311 Quantum Mechanics

PHYS 312 Applied Electromagnetism

PHYS 381 Advanced Experimental Physics and Astronomy

At least 15 additional points from PHYS 300 level

For Honours

90 points of 300-level PHYS or ASTR courses; and 30 points of 300-level MATH courses.

MATH 361, 342 and 371 are recommended

Note: students will normally be expected to have taken PHYS 311 and PHYS312. PHYS 326 is recommended.



Astronomy

Astronomy is the oldest science, from ancient China and classical Greece through the Renaissance, where Copernicus, Kepler and Newton made huge contributions to our knowledge and understanding of the solar system and planetary motion. But the science of astrophysics which seeks to explain the structure and evolution of the stars and other celestial objects by applying the principles of physics to interpret our observations, is little more than a century old.

Currently astronomy is undergoing huge expansion as we can now view the Universe at all wavelengths of the electromagnetic spectrum. Satellites can get above the atmosphere to detect gamma rays and on the ground huge telescope arrays many kilometers across make exciting discoveries with radio waves.

Electronic detectors, known as CCDs have replaced photography for optical observations in astronomy, and this data has led to new advances in our knowledge of the Universe.

Career paths

A career in astronomy might be as a university academic, or you might work in a government-funded observatory or institute. Many astronomers are also employed by the major space agencies, such as NASA and ESA. Some are also employed in public outreach programmes, such as in planetaria.

Astronomers have a broad training in many branches of physics as well as astronomy (such as optics, atomic physics, electronics, electromagnetism and radiophysics, nuclear physics, spectroscopy) and they are also skilled in computing and in image processing. All this means that students trained in astronomy are highly employable in many areas of science, technology or computing.

Honours and postgraduate

After completing your BSc you may enrol in a PGDipSc, MSc, or BSc(Hons), depending on your grades and the courses undertaken.

Excellent students may do a three-year BSc(Hons) if they have direct entry to 200-level Physics and Mathematics courses.

Year 1	Year 2	Year 3
<p>ASTR 112 Astrophysics</p> <p>PHYS 101 Engineering Physics A: Mechanics, Waves and Thermal Physics</p> <p>PHYS 102 Engineering Physics B: Electromagnetism, Modern Physics and 'How Things Work'</p> <p>MATH 102 Mathematics 1A</p> <p>MATH 103 Mathematics 1B</p> <p>Recommended</p> <p>MATH 170 Mathematical Modelling and Computation</p> <p>or</p> <p>COSC 121 Introduction to Computer Programming</p> <p>Note: It is possible to take ASTR 211 or ASTR 212 in Semester 2 of your first year of study.</p>	<p>ASTR 211 Imaging the Universe or...</p> <p>ASTR 212 The Solar System and Dynamical Astronomy</p> <p>PHYS 201 Waves and Optics</p> <p>PHYS 202 Electromagnetism and Mechanics</p> <p>PHYS 203 Relativistic and Quantum Physics</p> <p>PHYS 204 Thermal, Statistical and Particle Physics</p> <p>PHYS 285 Experimental Physics</p> <p>MATH 201 and 15 additional points from 200 level MATHS.</p> <p>MATH 202 and 203 are recommended.</p> <p>Recommended</p> <p>PHYS 286 Analogue and Digital Electronics</p> <p>MATH 270 Mathematical Modelling and Computation 2</p> <p>For honours</p> <p>45 points of 200-level MATH courses</p>	<p>ASTR 323 Stellar Structure and Evolution or</p> <p>ASTR 325 The Structure and Evolution of Galaxies</p> <p>ASTR 322 Theoretical and Observational Cosmology</p> <p>ASTR 381 Advanced Experiments in Physics and Astronomy</p> <p>At least 15 additional points of PHYS or ASTR 300-level</p> <p>Recommended</p> <p>PHYS 311 Quantum Mechanics</p> <p>PHYS 312 Applied Electromagnetism</p> <p>For honours</p> <p>90 points of 300-level PHYS or ASTR courses; and 30 points of 300-level MATH courses. MATH 361, 342 and 371 are recommended</p> <p>Note: students will normally be expected to have taken PHYS 311 and PHYS312. PHYS 326 is recommended</p>

Streams

Atmospheric Physics

The Atmospheric Physics stream allows interested students to be able to grasp the essential physics behind issues of current concern, such as the enhanced greenhouse effect and associated questions of climate change, the Antarctic ozone hole and global ozone depletion. It also allows the subtlety of nature to be observed by examining the seemingly simple processes of the formation of raindrops and the development of weather systems. Atmospheric physics also provides a huge variety of different disciplines within physics and other subjects to be explored and thus provides a highly challenging specialisation for the interested student.

Career paths

Majoring in this discipline equips you with strong quantitative problem solving skills. The skill set is applicable to a wide range of employment opportunities. Graduates in this discipline often find work in local meteorological services or in research institutes involved with atmospheric monitoring. Our graduates have also enjoyed careers with agencies in New Zealand, such as the National Institute of Water and Atmospheric Research Limited (NIWA) or regional councils.

Honours and postgraduate

After completing your BSc you may enrol in a PGDipSc, MSc, or BSc(Hons), depending on your grades and the courses undertaken.

Excellent students may do a three-year BSc(Hons) if they have direct entry to 200-level Physics and Mathematics courses.

Year 1

PHYS 101 Engineering Physics A: Mechanics, Waves and Thermal Physics

PHYS 102 Engineering Physics B: Electromagnetism, Modern Physics and 'How Things Work'

MATH 102 Mathematics 1A

MATH 103 Mathematics 1B

Recommended

MATH 170 Mathematical Modelling and Computation

or

COSC 121 Introduction to Computer Programming

Year 2

PHYS 201 Waves and Optics

PHYS 202 Electromagnetism and Mechanics

PHYS 203 Relativistic and Quantum Physics

PHYS 204 Thermal, Statistical and Particle Physics

PHYS 285 Experimental Physics

MATH 201 and 15 additional points from 200 level MATHS.

Recommended

PHYS 286 Analogue and Digital Electronics

MATH 270 Mathematical Modelling and Computation 2

For Honours

45 points of 200-level MATH courses

Year 3

PHYS 316 Geophysical Fluid Dynamics

PHYS 311 Quantum Mechanics

PHYS 312 Applied Electromagnetism

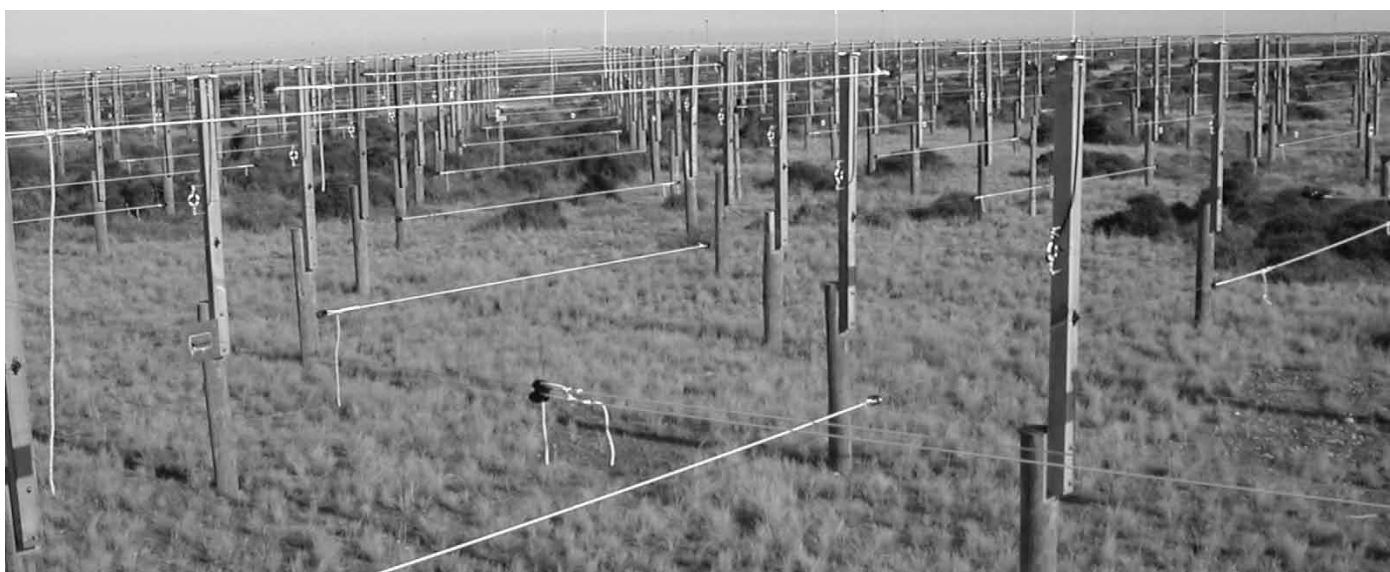
PHYS 381 Advanced Experimental Physics and Astronomy

At least 15 additional points from PHYS 300 level

For honours

90 points of 300-level PHYS or ASTR courses; and 30 points of 300-level MATH courses. MATH 361, 342 and 371 are recommended

Note: students will normally be expected to have taken PHYS 311 and PHYS312. PHYS 326 is recommended.



Radar antenna array for Atmospheric Research

Condensed Matter and Nanotechnology

Condensed Matter Physics and Nanotechnology are two disciplines concerned with understanding and developing materials to be used in the next generation of technology. In the case of nanotechnology, the critical dimensions are very small: only 1-100 nm, where the quantum properties of matter are often revealed and give exciting new possibilities for invention. Nanotechnology is also very interdisciplinary with engineers, physicists, chemists and biologists often linking together on a particular problem.

Our present high-tech society has been built on a foundation of discoveries by condensed matter physicists. Experiments on silicon in the 1950's led to the integrated circuit and microprocessor that is now so very common (and cheap).

More recently, there have been developments of sophisticated glass-fibre amplifiers that have made world communication and the Internet widely available. Where will the next devices come from? Perhaps it will be with high-temperature superconductors, or with spintronics, or from nanotechnology. Who knows, but condensed matter scientists are working to find out.

Career paths

A physics education provides a firm foundation of basic science and problem solving skills that allows employment in a wide range of settings well beyond the traditional boundaries of physics. Knowledge of condensed matter physics gives an insight into areas such as heat conduction and transfer, electrical and optical properties, and magnetism.

Often employment is found in research institutes where this background knowledge is used in the development of a particular material, eg, applications of superconductors to low-loss electrical transmission. Often employment can be found in the electronic industry where knowledge of semiconductors assists in product development and testing.

Honours and postgraduate

After completing your BSc you may enrol in a PGDipSc, MSc, or BSc(Hons), depending on your grades and the courses undertaken.

Excellent students may do a three-year BSc(Hons) if they have direct entry to 200-level Physics and Mathematics courses.

Year 1	Year 2	Year 3
PHYS 101 Engineering Physics A: Mechanics, Waves and Thermal Physics PHYS 102 Engineering Physics B: Electromagnetism, Modern Physics and 'How Things Work' MATH 102 Mathematics 1A MATH 103 Mathematics 1B Recommended MATH 170 Mathematical Modelling and Computation or COSC 121 Introduction to Computer Programming CHEM111 General Chemistry A	PHYS 201 Waves and Optics PHYS 202 Electromagnetism and Mechanics PHYS 203 Relativistic and Quantum Physics PHYS 204 Thermal, Statistical and Particle Physics PHYS 285 Experimental Physics MATH 201 and 15 additional points from 200 level MATHS. Recommended PHYS 286 Analogue and Digital Electronics MATH 270 Mathematical Modelling and Computation 2 For honours 45 points of 200-level MATH courses	PHYS 314 Condensed Matter Physics PHYS 311 Quantum Mechanics PHYS 312 Applied Electromagnetism PHYS 381 Advanced Experimental Physics and Astronomy At least 15 additional points from PHYS 300 level For honours 90 points of 300-level PHYS or ASTR courses; and 30 points of 300-level MATH courses. MATH 361, 342 and 371 are recommended Note: students will normally be expected to have taken PHYS 311 and PHYS312. PHYS 326 is recommended.

Streams (continued)

Medical Physics

Medical Physics is an accredited postgraduate degree programme. A BSc in Physics, or BEng in engineering in a related discipline (from another university) is required for entry into Medical Physics. Students should work to have a strong and broad undergraduate degree in physics. Students are advised to enrol in experimental, mathematical and computational courses at the undergraduate level. The necessary courses in anatomy, radiation effects and imaging must be taught at the postgraduate level.

Medical physicists use their scientific and technical skills to aid the prevention, diagnosis and treatment of disease. Many new methods for diagnosis and therapy are physical in nature, requiring the skills of medical physicists for research and development as well as their safe and effective application to patient care.

Medical physics provides an intellectually stimulating, multidisciplinary environment; personally rewarding work that may have a direct effect on patient care; and excellent career prospects in a field with a recognised shortage of suitably qualified graduates.

Career paths

Medical physics graduates are employed by hospitals in various department's including radiation oncology, diagnostic radiology and nuclear medicine. They are involved in creating new devices and technology, both in industry and academic environments. They also help to regulate the safe use of medical technology, including radiation safety.

Honours and postgraduate

After completing your BSc you may enrol in a PGDipSc, MSc, or BSc(Hons), depending on your grades and the courses undertaken.

Excellent students may do a three-year BSc(Hons) if they have direct entry to 200-level Physics and Mathematics.

A Doctorate (PhD) in Medical Physics is also available. MSc or PhD degrees can be earned with a clinical endorsement. Students holding a medical physics registrar position at a New Zealand hospital can earn the clinical endorsement.

To become a medical physicist, you will need experimental, mathematical and computational skills.

Year 1

- PHYS 101 Engineering Physics A: Mechanics, Waves and Thermal Physics
PHYS 102 Engineering Physics B: Electromagnetism, Modern Physics and 'How Things Work'
MATH 102 Mathematics 1A
MATH 103 Mathematics 1B

Recommended

- MATH 170 Mathematical Modelling and Computation
or
COSC 121 Introduction to Computer Programming

Year 2

Essential

- PHYS 201 Waves and Optics
PHYS 202 Electromagnetism and Mechanics
PHYS 203 Relativistic and Quantum Physics
PHYS 204 Thermal, Statistical and Particle Physics
PHYS 285 Experimental Physics
MATH 201 and 15 additional points from 200 level MATHS.

Recommended

- PHYS 286 Analogue and Digital Electronics
MATH 270 Mathematical Modelling and Computation 2

For honours

45 points of 200-level MATH courses

Year 3

- PHYS 311 Quantum Mechanics
PHYS 312 Applied Electromagnetism
PHYS 381 Advanced Experimental Physics and Astronomy

At least 15 additional points from PHYS 300 level

For honours

90 points of 300-level PHYS or ASTR courses; and 30 points of 300-level MATH courses. MATH 361, 342 and 371 are recommended

Note: students will normally be expected to have taken PHYS 311 and PHYS312. PHYS 326 is recommended.



Optical and Laser Physics

Optics (the study of light and the way it behaves when it interacts with matter) is one of the oldest branches of physics, and some of the greatest physicists (Newton, Maxwell, Einstein) have contributed. Classical optical physics is used to understand and design the commonplace and very modern optical instruments we use, such as cameras, binoculars and microscopes. The human eye is first and foremost an optical instrument.

The subject has undergone a rejuvenation in recent times, with the invention of many new devices and technologies, for instance: holography, lasers (of many kinds), CCD sensor arrays, light-emitting diodes, computer-aided optical design, computer-based image processing.

A sly joke of 40 years ago was that lasers were 'a solution looking for a problem'. Nobody would make that joke now. Lasers are used for zapping things (cutting and welding of metals and plastics, laser surgery, nuclear fusion research), for precision measurements (gauge blocks

using interferometry, distance to the moon to cm resolution, laser gyroscopes), alignment (tunnelling, laser levels), for military purposes (target designators, rangefinders), for measuring atmospheric pollution (spectroscopy, particle scattering), for fun (laser light shows, holograms). Some of their uses are so widespread (CD players, barcode scanners, overseas telephone calls via fibre-optic cables, laser printers) that it is easy to overlook that the devices depend on laser physics. Studying optical and laser physics helps you to find out how the modern world works!

Career paths

Optical and laser physics at first degree level, supplemented by other courses in general physics and/or electronics, leads to employment opportunities in many technical fields. Usually these jobs do not specialise solely in the laser and optical physics (although a few do, such as optical design and fabrication), but knowledge of how lasers and optics work is vital knowledge. For example, see all the uses of lasers listed earlier, and appreciate that there are people employed to install, use and fix these devices.

Honours and postgraduate

After completing your BSc you may enrol in a PGDipSc, MSc, or BSc(Hons), depending on your grades and the courses undertaken.

Excellent students may do a three-year BSc(Hons) if they have direct entry to 200-level Physics and Mathematics.

Optical physics and particularly laser physics lead to all manner of research opportunities, not just in physics but also chemistry, biology, and engineering. (It has been estimated that close to 20% of all research papers in the physical sciences and engineering have the use of lasers as an important ingredient.) At UC we have ongoing research in condensed matter physics using lasers, and we operate the world's largest ring laser gyroscope. We encourage good students to consider getting involved in this cutting-edge research for honours-level projects, and for MSc and PhD degrees in Physics

Year 1

- PHYS 101 Engineering Physics A: Mechanics, Waves and Thermal Physics
 PHYS 102 Engineering Physics B: Electromagnetism, Modern Physics and 'How Things Work'
 MATH 102 Mathematics 1A
 MATH 103 Mathematics 1B

Recommended

- MATH 171 Mathematical Modelling and Computation
 or
 COSC 121 Introduction to Computer Programming

Year 2

- PHYS 201 Waves and Optics
 PHYS 202 Electromagnetism and Mechanics
 PHYS 203 Relativistic and Quantum Physics
 PHYS 204 Thermal, Statistical and Particle Physics
 PHYS 285 Experimental Physics
 MATH 201 and 15 additional points from 200 level MATHS.

Recommended

- PHYS 286 Analogue and Digital Electronics
 MATH 270 Mathematical Modelling and Computation 2

For honours

45 points of 200-level MATH courses

Year 3

- PHYS 314 Condensed Matter Physics
 PHYS 310 Thermal, Statistical and Particle Physics
 PHYS 381 Advanced Experimental Physics and Astronomy
 PHYS 311 Quantum Mechanics
 PHYS 312 Applied Electromagnetism
 MATH 361 Partial Differential Equations

For honours

90 points of 300-level PHYS or ASTR courses; and 30 points of 300-level MATH courses.

Note: students will normally be expected to have taken PHYS 311 and PHYS312.

Streams (continued)

Theoretical and Mathematical Physics

Theoretical physics is the quest to reduce the physical world to a set of underlying principles that allows us to comprehend and understand it. This is an exciting area of physics where one strives to unlock the mysteries of the early universe and the sub-atomic domain. Mathematics provides a language to formulate and describe physics. Consequently it is highly recommended that a strong mathematical knowledge is developed. It is vital that the mathematical and conceptual reasoning and understanding are strong if one is to pursue a career in this research area.

Theoretical and Mathematical Physics research interests at UC focus on:

- The algebraic and geometric structure of spacetime
- Particle physics
- Neutrino astrophysics
- General relativity
- The origin and structure of the universe (Cosmology)
- Dark energy and dark matter
- Black holes
- Quantum gravity

Career paths

The skill set of a mathematical physicist is impressive and adaptable. The methods of thinking are applicable to a wide range of employment opportunities. Graduates find employment in scientific, mathematical and economic areas. A graduate may pursue

a research career as part of a leading edge research team developing the next generation of technology or furthering our understanding of the universe, a teaching career, or diversify into market forecasting, medical physics or any other endeavour requiring scientific or analytical reasoning.

Honours and postgraduate

After completing your BSc you may enrol in a PGDipSc, MSc, or BSc(Hons), depending on your grades and the courses undertaken. Excellent students may do a three-year BSc(Hons) if they have direct entry to 200-level Physics and Mathematics. At UC we have a special interdisciplinary Honours degree programme in Mathematical Physics with the Department of Mathematics and Statistics, providing an opportunity for candidates to become proficient in both physics and mathematics.

Year 1

- PHYS 101 Engineering Physics A: Mechanics, Waves and Thermal Physics
- PHYS 102 Engineering Physics B: Electromagnetism, Modern Physics and 'How Things Work'
- MATH 102 Mathematics 1A
- MATH 103 Mathematics 1B

Recommended

- MATH 170 Mathematical Modelling and Computation
- COSC121 Introduction to Computer Programming

Year 2

- PHYS 201 Waves and Optics
- PHYS 202 Electromagnetism and Mechanics
- PHYS 203 Relativistic and Quantum Physics
- PHYS 204 Thermal, Statistical and Particle Physics
- PHYS 285 Experimental Physics
- MATH 201 Mathematics 2
- MATH 202 Differential Equations and Vector Calculus
- MATH 203 Linear Algebra
- MATH 240 Analysis and Groups

For honours

45 points of 200-level MATH courses

Year 3

Preparation for Mathematical Physics Honours

- PHYS 311 Quantum Mechanics
- PHYS 312 Applied Electromagnetism
- PHYS 326 Classical Mechanics and Symmetry Principles
- PHYS 381 Advanced Experimental Physics and Astronomy

Four courses from

- MATH 361 Partial Differential Equations
- MATH 371 Vector Calculus and Modelling
- MATH 342 Application of Complex Variables
- MATH 322 Group Theory
- MATH 363 Dynamical Systems



Undergraduate courses

The following course information is accurate as of August 2010. However, course information is subject to change. Please check www.canterbury.ac.nz/courses for the latest information.

Astronomy courses

ASTR 109 The Cosmos: Birth and Evolution

15 Points 0.1250 EFTS
Descriptive overview of the universe. Earth impacts and extinctions by comets and asteroids. Solar system origins. The big bang and cosmology. Stellar birth and death. Life in the universe. Search for extraterrestrial intelligence (SETI) programmes.

R: PHYS 109, PHYS 110
EQ: PHYS 109
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
ASTR109-11S2 (C) Semester 2
Lect: Wed, Thu 12pm-1pm

ASTR 112 Astrophysics

15 Points 0.1250 EFTS
A general descriptive introduction to modern astrophysics: the Sun and stars, the Galaxy, extragalactic systems and cosmology.

Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
ASTR112-11S1 (C) Semester 1
Lect: Wed, Thu, Fri 12pm-1pm
Lab:
(F) Fri 2pm-5pm or
(P) Mon 2pm-5pm (only if numbers warrant)

ASTR 211 Imaging the Universe

15 Points 0.1250 EFTS
Have you ever seen the beautiful pictures of the Eagle Nebula made by the Hubble Space Telescope? Modern astronomical research relies heavily on advanced imaging technologies. In this course students will learn and apply the methods of digital astrophotography to make images of the Universe that are not only beautiful, but can be used to study questions such as: "What is the chemical makeup of galaxies?", "What are the temperatures of stars?" and "Is that nearby asteroid about to collide with the Earth?". The course will be taught in a very hands-on way, with the participation of students in tutorials and much of the assessment by way of practical assignments. The syllabus will include: telescopes, CCDs, filters general image processing methods astrometry, coordinate systems and time photometry spectroscopy.

P: 30 points from ASTR 112, MATH 100-level, STAT 100-level, PHYS 101-102, or PHYS 111. These prerequisites may be replaced by a high level of achievement in NCEA Level 3 Physics and Mathematics with Calculus or other background as approved by the Head of Department.
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
ASTR211-11S2 (C) Semester 2
Offered in odd-numbered years.

ASTR 212 Dynamical Astronomy and the Solar System

15 Points 0.1250 EFTS
Not offered in 2011
Orbital dynamics, the solar system and planetary exploration.
P: 30 points from ASTR 112, MATH 100-level, STAT 100-level, PHYS 101-102, or PHYS 111. These prerequisites may be replaced by a high level of achievement in NCEA Level 3 Physics and Mathematics with Calculus or other background as approved by the Head of Department.
Offered in even-numbered years.

ASTR 322 Theoretical and Observational Cosmology

15 Points 0.1250 EFTS
The nature, origin and evolution of the universe.
P: (1) Either (33 points from PHYS 221-224) or PHYS 203 and (PHYS 202 or PHYS 204). (2) MATH 103 or MATH 109 or EMTH 119.
R: PHYS 322
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
ASTR322-11S2 (C) Semester 2
Lect: Wed, Fri 1pm-2pm

ASTR 323 Stellar Structure and Evolution

15 Points 0.1250 EFTS
The physics governing stellar structure, a descriptive approach to stellar evolution, and related topics.
P: 22 points from PHYS 201-204, PHYS 221-PHYS 224, ASTR 211, ASTR 212; (2) MATH 103 or MATH 109 or EMTH 119
R: PHYS 323
EQ: PHYS 323
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
ASTR323-11S1 (C) Semester 1
Offered in odd-numbered years.

ASTR 324 Special Topic

15 Points 0.1250 EFTS
P: (1) 22 points from PHYS 221-PHYS 224, ASTR 211, ASTR 212; (2) MATH 103 or MATH 109 or equivalent
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
ASTR324-11S2 (C) Semester 2

ASTR 325 The Structure and Evolution of Galaxies

15 Points 0.1250 EFTS
Not offered in 2011
This course will give a thorough grounding in the physics of galaxies, covering galactic structure, dynamics, stellar populations, the Local Group. spiral galaxies, elliptical galaxies, galactic formation, galactic distribution and large-scale structure.
P: 22 points from PHYS 201-204, PHYS 221-PHYS 224, ASTR 211, ASTR 212; MATH 103 or MATH 109 or EMTH 119.
R: PHYS 325, ASTR 425
EQ: PHYS 325
Offered in even-number years.

ASTR 326 Special Topic

15 Points 0.1250 EFTS
P: (1) 22 points from PHYS 221 - PHYS 224, ASTR 211, ASTR 212; (2) MATH 109 or equivalent; (3) Entry subject to the approval of the Head of Department
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
ASTR326-11S1 (C) Semester 1
Offered in odd-numbered years.

ASTR 381 Advanced Experiments in Physics and Astronomy

15 Points 0.1250 EFTS
Execution and write-up of selected laboratory experiments.
P: (1) Either (PHYS 282 and 22 points from PHYS 221-224) or (PHYS 285 and 30 points from PHYS 201-204 including either PHYS 202 or PHYS 204). (2) MATH 103 or MATH 109 or EMTH 119.
R: PHYS 381
EQ: PHYS 381
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
ASTR381-11S1 (C) Semester 1
Lab: Thu, Fri 2pm-5pm
ASTR381-11S2 (C) Semester 2
Lab: Thu, Fri 2pm-5pm
This course is normally taken in Semester 2. Entry for SU2 or S1 will only be granted by the HOD in exceptional circumstances.

ASTR 391 Introductory Astronomy Research

15 Points 0.1250 EFTS
150 hours of research undertaken with the supervision of an active researcher. To be assessed with an oral presentation 20%, and a short written report 80%. This course may be started at any time with the agreement of the HOD. Note that start and end dates may affect entitlement to Studylink support.
P: (1) MATH 103 or MATH 109 or equivalent (2) 44 points from PHYS 200 or ASTR 200 (3) Entry subject to a supervisor approved by the Head of Department, being available
R: ASTR 392, ASTR 393
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
ASTR391-10SU2 (C) Summer (Nov 10)
ASTR391-11S1 (C) Semester 1
ASTR391-11S2 (C) Semester 2
1. This course cannot be credited to the 56 points of 300 level ASTR required for ASTR major. 2. Entry subject to a supervisor being approved by the HOD being available.

Undergraduate courses (continued)

Electronics courses

ELEC 201 Fundamentals of Electronics

15 Points 0.1250 EFTS
This course provides the student with an introduction to the basic principles of circuit theory. In particular, RLC circuits, sensors, filters, operational amplifiers and simulation techniques are examined.

P: (1) PHYS 102 or PHYS 114 (2) MATH 102 or EMTH 118 or MATH 108. These prerequisites may be replaced by a high level of achievement in NCEA Level 3 Physics and Mathematics with Calculus or other background as approved by the Head of Department.

R: ELEC 227, ENME 339

Domestic Fee: \$703 (2010)

International Fee: \$3,538 (2010)

ELEC201-11S1 (C) Semester 1

Lect: Wed, Thu 12pm-1pm, Fri 11am-12pm

Lab: Fri 2pm-5pm

ELEC 202 Analogue and Digital Electronics

15 Points 0.1250 EFTS

The aim of the course is to enable students to understand various analogue and digital devices and its circuits. It covers topics in Analogue Electronics, advanced circuit theory and Digital Electronics. It also introduces to circuit theorems, discrete semiconductor devices, semiconductor integrated circuits, the characteristics and applications of these semiconductor devices and circuits. Emphasis is on analysis, selection, biasing, and applications. This course also covers number systems, Boolean algebra, logic families, combinational and sequential logic circuits.

P: (1) PHYS 102 or PHYS 114 (2) MATH 102 or EMTH 118 or MATH 108. These prerequisites may be replaced by a high level of achievement in NCEA Level 3 Physics and Mathematics with Calculus or other background as approved by the Head of Department.

R: ELEC 225, ELEC 226, PHYS 225, PHYS 226, PHYS 286

EQ: PHYS 286

Domestic Fee: \$703 (2010)

International Fee: \$3,538 (2010)

ELEC202-11S2 (C) Semester 2

Lect: Mon 2pm-3pm, Fri 1pm-2pm

Lab:

(A) Tu 2pm-5pm or

(B) Wed 2pm-5pm

ELEC 312 Applied Electromagnetism

15 Points 0.1250 EFTS

The development of the Maxwell equations in differential form. The propagation of electromagnetic waves in free space, dielectrics and conducting media, their behaviour at dielectric interfaces and their production from radiating sources.

P: (1) PHYS 202 or PHYS 224 or ENEL 204; (2) MATH 103 or MATH 109 or EMTH 119

R: PHYS 312

EQ: PHYS 312

Domestic Fee: \$650 (2010)

International Fee: \$3,000 (2010)

ELEC312-11S2 (C) Semester 2

ELEC 321 Electronics Design

15 Points 0.1250 EFTS

The course is to enable students to be able to design and analyse analogue and digital circuits for everyday applications. Students will employ computer based simulation tools such as Pspice to assist in performing functional analysis and performance validation.

P: (1) ELEC 201 and ELEC 202 or ELEC 225 and ELEC 226; (2)

MATH 103 or MATH 109 or equivalent; (3) COSC 208

Domestic Fee: \$650 (2010)

International Fee: \$3,000 (2010)

ELEC321-11S1 (C) Semester 1

Lect: Wed, Thu 2pm-3pm

Lab: Mon 2pm-5pm

ELEC 322 Industrial Electronics

15 Points 0.1250 EFTS

Not offered in 2011

Topics include various electronic sensors, electronics for signal conditioning, programmable logic controllers, actuator systems and industrial data communication.

P: (1) ELEC 201 and ELEC 202 or ELEC 225 and ELEC 226; (2)

MATH 103 or MATH 109 or equivalent

ELEC 323 Instrumentation

15 Points 0.1250 EFTS

This course is to enable the student to gain the tools to perform interfacing between instruments and computers using commercial data acquisition cards. The main emphasis will be on programming using the LabVIEW package, data acquisition, and signal conditioning.

P: (1) ELEC 201 and ELEC 202 or ELEC 226 and ELEC 227; (2)

MATH 103 or MATH 109 or equivalent

R: PHYS 319

Domestic Fee: \$650 (2010)

International Fee: \$3,000 (2010)

ELEC323-11S2 (C) Semester 2

ELEC 325 Special Topic

15 Points 0.1250 EFTS

P: Entry by permission of the Head of Department of Physics and Astronomy.

Domestic Fee: \$650 (2010)

International Fee: \$3,000 (2010)

ELEC325-11S1 (C) Semester 1

ELEC 326 Special Topic

15 Points 0.1250 EFTS

P: Entry by permission of the Head of Department of Physics and Astronomy.

Domestic Fee: \$650 (2010)

International Fee: \$3,000 (2010)

ELEC326-11S2 (C) Semester 2

ELEC 361 Microprocessor Systems 1

15 Points 0.1250 EFTS

An introduction to the architecture, operation and application of microprocessor systems.

P: (1) ELEC 202 or ELEC 226; (2) MATH 103 or MATH 109 or equivalent

R: COSC 361

EQ: COSC 361

Domestic Fee: \$626 (2010)

International Fee: \$2,813 (2010)

ELEC361-11S1 (C) Semester 1

Lect: Tu 12pm-1pm, Thu 3pm-4pm

Lab: Wed 9am-11am

ELEC 381 Advanced Electronics Design Laboratory

15 Points 0.1250 EFTS

Execution and write-up of selected laboratory experiments and an approved independent project with an electronics design element.

P: (1) 28 points from ELEC 300, including ELEC 321; (2)

COSC 208

Domestic Fee: \$650 (2010)

International Fee: \$3,000 (2010)

ELEC381-10SU2 (C) Summer (Nov 10)

ELEC381-11S1 (C) Semester 1

Lab: Thu, Fri 2pm-5pm

ELEC381-11S2 (C) Semester 2

Lab: Thu, Fri 2pm-5pm

This course is normally taken in Semester 2. Entry for SU2 or S1 will only be granted by the HOD in exceptional circumstances.

Physics courses

PHYS 101 Engineering Physics A: Mechanics, Waves and Thermal Physics

15 Points 0.1250 EFTS

This is a required course for all Engineering Programmes as well as Physics, Astronomy and Electronics degrees.

PHYS101 builds on NCEA level 3 physics to develop Mechanics, Conservation Laws, Fluids, Waves and Thermal Physics into an essential foundation for science and technology understanding.

P: PHYS 111 or 14 credits NCEA Level 3 Physics and 14 credits NCEA Level 3 Mathematics with Calculus. These prerequisites may be replaced by other background as approved by the Head of Department.

R: PHYS 113, PHYS 112

EQ: PHYS 113

Domestic Fee: \$703 (2010)

International Fee: \$3,538 (2010)

PHYS101-11S1 (C) Semester 1

Lect:

(A) Mon, Tu, Wed 11am-12pm or

(B) Mon, Tu, Wed 3pm-4pm or

(C) Mon, Tu, Wed 1pm-2pm

Lab:

(L) Mon 9am-12pm or

(M) Tu 9am-12pm or

(N) Wed 9am-12pm or

(O) Thu 9am-12pm or

(P) Mon 2pm-5pm or

(Q) Tu 2pm-5pm or

(R) Wed 2pm-5pm or

(S) Thu 2pm-5pm or

(T) Fri 9am-12pm

PHYS101-11S2 (C) Semester 2

Lect: Mon, Wed, Thu 10am-11am

Lab:

(M) Tu 9am-12pm or

(P) Mon 2pm-5pm or

(Q) Tu 2pm-5pm or

(R) Wed 2pm-5pm or

(S) Thu 2pm-5pm or

(T) Fri 9am-12pm

PHYS 102 Engineering Physics B: Electromagnetism, Modern Physics and "How Things Work"

15 Points 0.1250 EFTS
An essential course for students advancing in physical sciences and engineering who need a good understanding of electromagnetism and concepts of modern physics. The first section covers the E&M necessary to understand basic circuit theory, magnetic field concepts and finally applications such as power technology and electronics. The second section introduces aspects of modern physics such as quantum effects in atoms and materials, radioactivity and nuclear processes. Finally the course finishes with a section titled "How things work – the physics behind modern technology". A series of guest lecturers will elaborate on the physics behind applications such as radar, medical imaging, data storage, lasers, etc.

P: PHYS 101.
R: PHYS 114, PHYS 115
RP: These prerequisites may be replaced by other background as approved by Head of Department

EQ: PHYS 114
Domestic Fee: \$703 (2010)
International Fee: \$3,538 (2010)
PHYS102-10SU2 (C) Summer (Nov 10)
PHYS102-11S2 (C) Semester 2

Lect:
(A) Mon, Tu, Wed 11am-12pm or
(B) Mon, Tu, Wed 3pm-4pm
Lab:
(L) Mon 9am-12pm or
(P) Mon 2pm-5pm or
(Q) Tu 2pm-5pm or
(R) Wed 2pm-5pm or
(S) Thu 2pm-5pm or
(T) Fri 9am-12pm

PHYS 109 The Cosmos: Birth and Evolution

15 Points 0.1250 EFTS
Descriptive overview of the universe. Earth impacts and extinctions by comets and asteroids. Solar system origins. The big bang and cosmology. Stellar birth and death. Life in the universe. Search for extraterrestrial intelligence (SETI) programmes.

R: ASTR 109, PHYS 110
EQ: ASTR 109
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
PHYS109-11S2 (C) Semester 2
Lect: Wed, Thu 12pm-1pm

PHYS 111 Introductory Physics for Physical Sciences and Engineering

15 Points 0.1250 EFTS
Classical dynamics, oscillations, temperature and heat, D.C. circuits, geometrical optics and interference, nuclear physics.

R: PHYS 106. Students who have been credited with any of PHYS 101, PHYS 102, PHYS 113 or PHYS 114 cannot subsequently be credited with PHYS 111.

Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
PHYS111-11S1 (C) Semester 1
Lect: Mon, Wed, Thu 10am-11am

Lab:
(K) Fri 9am-12pm or
(M) Tu 9am-12pm or
(P) Mon 2pm-5pm or
(Q) Tu 2pm-5pm or
(R) Wed 1pm-4pm or
(S) Thu 2pm-5pm

PHYS 201 Waves and Optics

15 Points 0.1250 EFTS
Physics of wave oscillations and their applications in numerous different physical systems. The essential elements of optics are covered including an exposition of key modern developments.

P: (1) PHYS 101; (2) MATH 102 or EMTH 118. These prerequisites may be replaced by a high level of achievement in level 3 NCEA Physics and Mathematics with Calculus or other background approved by the Head of Department.

R: PHYS 221
RP: (1) PHYS 102; (2) MATH 103 or EMTH 119.
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)

PHYS201-11S1 (C) Semester 1

PHYS 202 Electromagnetism and Mechanics

15 Points 0.1250 EFTS
The treatment of electricity and magnetism from observed phenomena through to the Maxwell equations in integral form; magnetic and dielectric properties of materials. Rotations, angular momentum, rigid bodies, orbits, rotating frames of reference.

P: (1) PHYS 102; (2) MATH 102 or EMTH 118. These prerequisites may be replaced by a high level of achievement in level 3 NCEA Physics and Mathematics with Calculus or other background approved by the Head of Department.

R: PHYS 224
RP: MATH 103 or EMTH 119.
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)

PHYS202-11S2 (C) Semester 2

PHYS 203 Relativistic and Quantum Physics

15 Points 0.1250 EFTS
Introduction to relativistic mechanics, including space-time transformations, dynamics and collisions of relativistic particles. Introduction to quantum physics, bringing out its applications, including wave-particle duality, one dimensional barriers and wells, electron spin, electron configuration of atoms, lasers, semiconductors and quantum dots.

P: (1) PHYS 102; (2) MATH 102 or EMTH 118. These prerequisites may be replaced by a high level of achievement in level 3 NCEA Physics and Mathematics with Calculus or other background approved by the Head of Department.

R: PHYS 222
RP: MATH 103 or EMTH 119.
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
PHYS203-11S1 (C) Semester 1

PHYS 204 Thermal, Statistical and Particle Physics

15 Points 0.1250 EFTS
This course provides an introduction to the study of the physical properties of matter. It integrates the study of thermal properties of matter in bulk (thermodynamics) with the molecular/atomic approach (statistical physics). The particle physics is further extended to subatomic scales with an introduction to the phenomenology of nuclear structure, radiation processes and the standard model of particle interactions.

P: (1) PHYS 203; (2) MATH 103 or EMTH 119.
R: PHYS 310
RP: MATH 201
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)

PHYS204-11S2 (C) Semester 2

PHYS 285 Experimental Physics

15 Points 0.1250 EFTS
A laboratory based course in experimental techniques, data acquisition and analysis for second-year physics/astronomy students.

P: (1) PHYS 102; (2) MATH 102 or EMTH 118 (3) MATH 170 or EMTH 171 or COSC 121 or MATH 280 or MATH 282 or another approved course involving programming. These prerequisites may be replaced by a high level of achievement in level 3 NCEA Physics and Mathematics with Calculus or other background approved by the Head of Department.

R: PHYS 281, PHYS 282
RP: MATH 103 or EMTH 119.
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
PHYS285-11S1 (C) Semester 1

PHYS 286 Analogue and Digital Electronics

15 Points 0.1250 EFTS
The aim of the course is to enable students to understand various analogue and digital devices and its circuits. It covers topics in Analogue Electronics, advanced circuit theory and Digital Electronics.

It also introduces to circuit theorems, discrete semiconductor devices, semiconductor integrated circuits, the characteristics and applications of these semiconductor devices and circuits. Emphasis is on analysis, selection, biasing, and applications. This course also covers number systems, Boolean algebra, logic families, combinational and sequential logic circuits.

P: (1) PHYS 102 or PHYS 114 (2) MATH 102 or EMTH 118 or MATH 108. These prerequisites may be replaced by a high level of achievement in NCEA Level 3 Physics and Mathematics with Calculus or other background as approved by the Head of Department.

R: ELEC 202
EQ: ELEC 202
Domestic Fee: \$703 (2010)
International Fee: \$3,538 (2010)
PHYS286-11S2 (C) Semester 2
Lect: Mon 2pm-3pm, Fri 1pm-2pm
Lab:
(T) Tu 2pm-5pm or
(W) Wed 2pm-5pm

PHYS 310 Thermal Statistical and Particle Physics

15 Points 0.1250 EFTS
Development of statistical mechanics from thermodynamic principles. Entropy interpreted from both the thermodynamic and statistical viewpoint. Applications in nuclear and particle physics including radioactivity.

P: (1) 22 points from PHYS 221-PHYS 224; (2) MATH 103 or MATH 109 or equivalent.

R: PHYS 204
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
PHYS310-11S2 (C) Semester 2

Undergraduate courses (continued)

PHYS 311 Quantum Mechanics

15 Points 0.1250 EFTS
Development of quantum mechanics from basic postulates, using operator techniques, with application of the formalism to a variety of systems; time-independent perturbation theory.
P: (1) PHYS 203 or PHYS 222; (2) MATH 103 or MATH 109 or EMTH 119.
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
PHYS311-11S1 (C) Semester 1
Lect: Mon, Tu 11am-12pm

PHYS 312 Applied Electromagnetism

15 Points 0.1250 EFTS
The development of the Maxwell equations in differential form. The propagation of electromagnetic waves in free space, dielectrics and conducting media, their behaviour at dielectric interfaces and their production from radiating sources.
P: (1) PHYS 202 or PHYS 224; (2) MATH 103 or MATH 109 or EMTH 119
R: ELEC 312
EQ: ELEC 312
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
PHYS312-11S2 (C) Semester 2

PHYS 314 Condensed Matter Physics

15 Points 0.1250 EFTS
The structure of solids and methods of determination; the dynamic and electrical conduction properties of solids, including superconductivity.
P: (1) PHYS 203 or PHYS 222; (2) MATH 103 or MATH 109 or EMTH 119
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
PHYS314-11S2 (C) Semester 2

PHYS 316 Geophysical Fluid Dynamics

15 Points 0.1250 EFTS
Principles of the dynamics of an incompressible, non-viscous, rotating fluid applied to large-scale motion of the Earth's atmosphere and oceans.
P: (1) One of PHYS 201, PHYS 202, PHYS 203, PHYS 221, PHYS 223, PHYS 224; (2) MATH 103 or MATH 109 or EMTH 119.
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
PHYS316-11S1 (C) Semester 1
Lect: Tu, Wed 9am-10am

PHYS 322 Theoretical and Observational Cosmology

15 Points 0.1250 EFTS
The nature, origin and evolution of the universe.
P: (1) Either 33 points from PHYS 221-224 or PHYS 203 and (PHYS 202 or PHYS 204); (2) MATH 103 or MATH 109 or EMTH 119.
R: ASTR 322
EQ: ASTR 322
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
PHYS322-11S2 (C) Semester 2
Lect: Wed, Fri 1pm-2pm

PHYS 323 Stellar Structure and Evolution

15 Points 0.1250 EFTS
The physics governing stellar structure, a descriptive approach to stellar evolution, and related topics.
P: (1) 22 points from PHYS 201-204, PHYS 221-PHYS 224, ASTR 211, ASTR 212; (2) MATH 103 or MATH 109 or EMTH 119
R: ASTR 323
EQ: ASTR 323
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
PHYS323-11S1 (C) Semester 1
Offered in odd-numbered years.

PHYS 325 The Structure and Evolution of Galaxies

15 Points 0.1250 EFTS
Not offered in 2011
This course will give a thorough grounding in the physics of galaxies, covering galactic structure, dynamics, stellar populations, the Local Group, spiral galaxies, elliptical galaxies, galactic formation, galactic distribution and large-scale structure.
P: 22 points from PHYS 201-204, PHYS 221-PHYS 224, ASTR 211, ASTR 212; MATH 103 or MATH 109 or EMTH 119.
R: ASTR 325, ASTR 425
EQ: ASTR 325
Offered in even-number years.

PHYS 326 Classical Mechanics and Symmetry Principles

15 Points 0.1250 EFTS
The Lagrangian and Hamiltonian formulations of classical mechanics which provide essential preparation for all advanced courses in theoretical physics. Techniques learned have wide use in advanced quantum mechanics, quantum field theory, general relativity, particle physics and statistical mechanics.
P: P: (1) (PHYS 203 or PHYS 223) and (PHYS 202 or PHYS 204 or PHYS 222 or PHYS 224); (2) MATH 201 or MATH 261 or MATH 264
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
PHYS326-11S1 (C) Semester 1
Lect: Wed, Thu 11am-12pm

PHYS 327 Special Topic

15 Points 0.1250 EFTS
P: (1) HOD approval; (2) MATH 103 or MATH 109 or equivalent.
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
PHYS327-11S1 (C) Semester 1

PHYS 328 Special Topic

15 Points 0.1250 EFTS
P: (1) HOD approval; (2) MATH 103 or MATH 109 or equivalent.
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
PHYS328-11S2 (C) Semester 2

PHYS 329 Special Topic

15 Points 0.1250 EFTS
P: (1) HOD approval; (2) MATH 103 or MATH 109 or equivalent.
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
PHYS329-11S1 (C) Semester 1

PHYS 381 Advanced Experimental Physics and Astronomy

15 Points 0.1250 EFTS
Execution and write-up of selected laboratory experiments.
P: (1) Either (PHYS 282 and 22 points from PHYS 221-224) or (PHYS 285 and 30 points from PHYS 201-204 including either PHYS 202 or PHYS 204). (2) MATH 103 or MATH 109 or EMTH 119.
R: ASTR 381
EQ: ASTR 381
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
PHYS381-11S1 (C) Semester 1
Lab: Thu, Fri 2pm-5pm
PHYS381-11S2 (C) Semester 2
Lab: Thu, Fri 2pm-5pm
This course is normally taken in Semester 2. Entry for SU2 or S1 will only be granted by the HOD in exceptional circumstances.

PHYS 391 Introductory Physics Research

15 Points 0.1250 EFTS
150 hours of research undertaken with the supervision of an active researcher. To be assessed with an oral presentation 20%, and a short written report 80%. This course may be started at any time with the agreement of the HOD. Note that start and end dates may affect entitlement to Studylink support.
P: (1) MATH 103 or MATH 109 or equivalent (2) 44 points from PHYS 200 (3) Entry subject to a supervisor approved by the Head of Department, being available
R: PHYS 392, PHYS 393
Domestic Fee: \$650 (2010)
International Fee: \$3,000 (2010)
PHYS391-10SU2 (C) Summer (Nov 10)
PHYS391-11S1 (C) Semester 1
PHYS391-11S2 (C) Semester 2
(1) Cannot be credited to the 56 points at 300 level PHYS required for a PHYS major. (2) Comprises 150 hours Research Practice.

Student profiles



Alicia Cavan BSc(Hons) student

Alicia Cavan recently completed her study toward a Bachelor of Science with Honours majoring in Medical Physics and is now well on her way toward a PhD in Medical Physics. She has been the recipient of both the 2006 University of Canterbury Emerging Leadership Scholarship and the 2007 NZ Institute of Physics Prize.

Alicia says she chose to study physics because she liked learning about the fundamental way that the world works. "I like the way that if you understand the concepts then you can apply them to a whole range of situations to understand why something happens. I also enjoy how there are so many different aspects to physics, from quantum mechanics to electromagnetism to medical physics."



Alicia says that it was during her Honours year that she began to really enjoy the applied nature of Medical Physics, "seeing how the theory that we have learned can be used to treat people. She likes the way that the theoretical lectures are integrated with learning about research tools, and trips to the hospital to see the things we are learning about put into practice.

Alicia says that all her lecturers have been great, "really good at explaining the concepts". She thinks this is because they are able to talk about the research that they are involved in, so they are passionate about the subject, and can relate what we are learning to active research areas. Several of the Medical Physics lecturers also work at the hospital, so we know that what we are learning is up to date and relevant. The lecturers were always really willing to help out when we have any extra questions.

In the future Alicia would like to work in a hospital as a Medical Physicist, splitting her time between research and clinical work.

When she is not studying Alicia's other passion is Kendo (Japanese fencing). She trains three to four times a week at the Canterbury Kendo Club, and is also heavily involved in running the club, acting as treasurer, and instructing beginner's classes. Alicia has won the NZ Women's Open at the National Championships twice in the last three years, and she travelled to Brazil representing New Zealand at the 14th World Kendo Championships.

Student profiles (continued)



Kirk Pritchard BSc majoring in Physics

Kirk Pritchard is a Physics graduate who completed his studies in 2005. In March 2006 he took up a position working at the dams in Central Otago for Contact Energy as a Dispatch Trader.

The job entails two main aspects. The first part is operating the power generation assets owned by Contact Energy on the Clutha River (Clyde and Roxburgh dams as well as the flow control structure at Hawea). The second involves managing the daily trading of all power generated by Contact on the NZEM (New Zealand Electricity Market). This is done on a 24 hour a day roster comprising of nine members of which Kirk is one.

Kirk says that his BSc from UC gave him many of the skills and knowledge which he applies on a day to day basis: knowing how a generator actually creates electricity; how transformers work; how potential energy is turned into mechanical and then electrical energy in a hydro station; understanding the concept of impedance; real, reactive and apparent power, along with many other aspects of the job. His job, even though it has an economic market aspect with the trading side of things, is very well suited to someone with a scientific background and all members of the team he works with have some sort of scientific or practical background.

Kirk enjoys his job very much and doubts he would be there without the skills he gained studying toward a BSc in Physics at UC.



Graeme Plank MSc

Graeme has a long history in the Department of Physics and Astronomy at UC. He completed his BSc with the intention of becoming a school teacher. However, the next year he followed a research path, growing and studying fluorite crystals in the infra-red part of the electromagnetic spectrum. He was awarded a Master of Science (MSc) for this work.

While awaiting his thesis examination a position within the Department became available. The opportunity to travel to Antarctica that came with the position was too much to resist so Graeme took on the role of Atmospheric Group Technician. Radio frequency and electronics courses Graeme took as part of his previous studies aided the shift in career.

The role encompassed the day to day running of the atmospheric research RADAR sites at Birdlings Flat, Scott Base in the Antarctic along with smaller research sites near Eyrewell and Mt John.

Graeme says, 'The great things about working for this Department is the team atmosphere we have here, the work being so varied and the chance to get out of the office and work outdoors is just fantastic. After a dozen trips to Antarctica I'm still excited at the thought of the next one'.

Along with supporting research Graeme has tried to bring physics out into the local community. He has been involved in public firewalks throughout the country for many years, judged science fairs and has been a regular contributor of interviews and physics challenges to the local MoreFM radio station.



Emi Piuilā-Afitu BSc(Hons)

Emi says, 'My Physics degree from UC gave me a great base to gain exciting work opportunities in the UK and now in NZ'.

Six months after completing her studies Emi travelled to the UK. She was able to secure a job as an Optical Radiation scientist at the UK's National Standards Lab which is called the National Physical Laboratory (NPL). She feels her success in gaining this position was due to the high quality of her degree.

Emi's work at NPL originally involved calibrations and research and development. Later she diversified into the business side of science. Emi was instrumental in creating science programmes, which she did by interfacing between industry, scientists and government.

Emi is now back in New Zealand and working for the Industry Capability Network (ICN) as an Advisor in the Energy Sector. ICN is a business unit within NZ Trade & Enterprise (NZTE). The role of ICN is to get more NZ businesses working on large NZ-based projects.

Emi credits her UC education with helping her achieve her career goals to date by providing her with necessary knowledge and the ability to understand technical documents and specifications.

Postgraduate degrees in Physics and Astronomy

Postgraduate degrees taken by students include the Postgraduate Diploma in Science (PGDipSc), Master of Science (MSc), Bachelor of Science (Honours), (BSc(Hons)), and Doctor of Philosophy (PhD). These can be taken in Physics, Astronomy, Mathematical Physics or Medical Physics.

Any student who wishes to enrol for a research degree should contact an academic staff member of the Department for further information and advice. Also visit our website at www.phys.canterbury.ac.nz

Bachelor of Science with Honours (BSc(Hons))

Entry into BSc(Hons) requires more 300-level courses than a minimal BSc, and good grades, especially at 300-level. At 400-level BSc(Hons), you will do 150 credit points, a research project (PHYS/ASTR/MAPH 480) and eight lecture courses. Details of the BSc(Hons) entry requirements maybe found in the Enrolment Handbook. As a general rule the requirement is 90 points in 300-level Physics and Astronomy and 30 points in 300-level Mathematics.

Master of Science (MSc)

The Master of Science is normally a two-year degree. The requirements for Part I are similar to those for the PGDipSc, except that physics and astronomy students must include respectively PHYS 480 or ASTR 480 research projects in their programme.

Part II of the MSc is a one-year thesis. Able students may be allowed to take both parts concurrently over two years. Students who have already qualified for a BSc(Hons) degree or PGDipSc in a subject may be admitted directly to the MSc (Part II) (thesis only) in that same subject.

Postgraduate Diploma in Science (PGDipSc)

The Postgraduate Diploma in Science is a one-year course equivalent to the first year of a Master of Science degree (Part I). In Physics, the programme is five lecture courses (from PHYS 401–460) and a research project (PHYS 480), or eight lecture courses from PHYS 401–460. In Astronomy, students should take ASTR 424 and



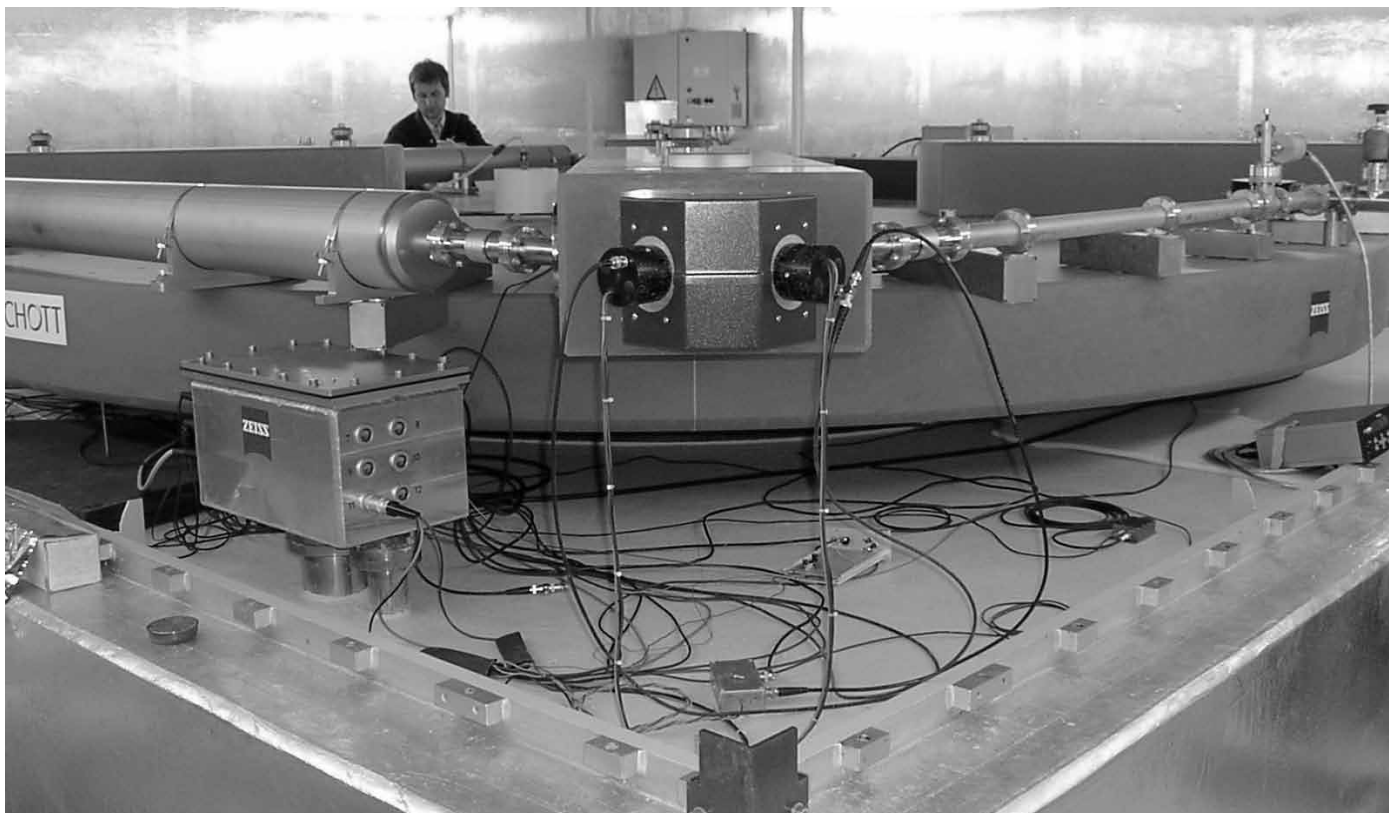
seven courses from ASTR 421–423, 425–430; up to two of these courses may be replaced by PHYS 400-level courses and three may be replaced by a research project (ASTR 480). In Medical Physics, six courses are chosen from MDPH 401–410.

Doctor of Philosophy

The Doctor of Philosophy (PhD) degree is normally a three-year research degree, which may in some circumstances be extended to four years. The entry requirement is a BSc(Hons) degree minimum second class honours division 1, or an MSc degree with a good grade point average (GPA).

A PhD may be undertaken in Physics, Astronomy or Medical Physics within our Department. For mathematical physics (MAPH 480) research projects and theses (MSc and PhD), students have access to the research facilities of the Department, including those in astronomy, atmospheric physics, ring laser physics, nanotechnology, condensed matter physics and theoretical physics. In addition, you may be able to collaborate with researchers in several international partnerships which involve our Department. For research in medical physics, students will have access to the medical physics facilities at the Christchurch Clinical School and Christchurch Hospital.

Research, field stations and international collaborations



Students who are in their final year of the BSc or BSc(Hons) degrees will normally come into contact with researchers in one or more of the research groups active in our Department.

Our research is broadly focussed in the following six areas of physics and astronomy:

- Atmospheric physics
- Astronomy and astrophysics
- Condensed matter physics and nanotechnology
- Theoretical physics (including mathematical physics, general relativity and cosmology)
- Ring laser physics (with applications in geophysics)
- Medical physics

Several of these research groups operate field stations which are run by the Department. These include Birdlings Flat (radar studies of the upper atmosphere and of meteor orbits), Mt John Observatory in Tekapo (optical astronomy), the Cashmere Cavern (housing

several ring lasers in an underground laboratory), as well as a facility at Arrival Heights in the Antarctic (atmospheric physics).

For more in-depth detail on our field stations go to www.phys.canterbury.ac.nz/field_stations.shtml

Atmospheric Physics

The atmospheric group at UC studies and monitors the dynamics of the atmosphere using radar systems located at the Department's Research Facilities in New Zealand, at Birdlings Flat, and in Antarctica, at Scott Base. These observations provide high resolution measurements of the winds in the atmosphere which are used in conjunction with satellite observations and atmospheric models to understand a wide variety of atmospheric processes.

A recent focus has been the examination of the impact of planetary-scale waves on the Antarctic middle atmosphere in collaboration with researchers at the British Antarctic Survey UK, University of Colorado USA, Australian Antarctic Division and Japan. Radar sensing of meteoric ionization is employed to map the space trajectories of Earth-impacting meteoroids,

to study ionic products and as a probe to monitor atmospheric tidal dynamics and turbulent features.

Astronomy and Astrophysics

The astronomy research group at UC studies stars at optical wavelengths. For this purpose the Department operates Mt John Observatory at Lake Tekapo with 1.8-, 1.0- and two 0.6 m telescopes. The work concentrates on stellar photometry and spectroscopy.

A wide variety of different types of variable and binary stars are observed, as well as studies being carried out on the chemical element abundances in evolved stars using spectroscopy. The University of Canterbury is a partner in the Southern African Large Telescope (SALT), which was a project to build a 11 m telescope in South Africa. This instrument was completed in 2005. In addition there is an ongoing collaboration with Nagoya University in Japan to study gravitational microlensing (the MOA project). UC astronomers participate in several other collaborative projects which entail using data from the Hubble Space Telescope, the Anglo-Australian Telescope and from other observatories world-wide.

Condensed Matter Physics and Nanotechnology

The condensed matter group is interested in the properties of materials from millimetre size right down to the scale where quantum behaviour of the atoms becomes important. At these small dimensions, on the scale of nanometres, materials take on new physical properties and thus present the opportunity for new science and applications. This is the field of Nanotechnology.

Our group has several primary directions in the field of nanotechnology. We have developed techniques where extremely small clusters of metal or semiconductor atoms can be produced and arranged to form conducting wires with sizes much smaller than are possible by conventional means. This technology was behind New Zealand's first nanotechnology spin-off company, Nano-Cluster Devices. Our current focus is on novel switching behaviour (which might be useful in new memory devices) in these devices, and on fundamental issues related to superconductivity in these nanoscale systems.

Our group also has an active programme in the growth and characterisation of new semiconductor thin films. In particular we have a suite of optical spectroscopy facilities that allow photoluminescence, photoconductivity and Raman spectroscopy studies of many types of material, over a broad range of wavelengths. This work attempts to enlarge the range of materials that have applications in our high-tech opto-electronic industries.

The academic staff of the group are Principal Investigators in the MacDiarmid Institute for Advanced Materials and Nanotechnology. Through this Institute, the researchers have access to very sophisticated characterisation facilities for their work.

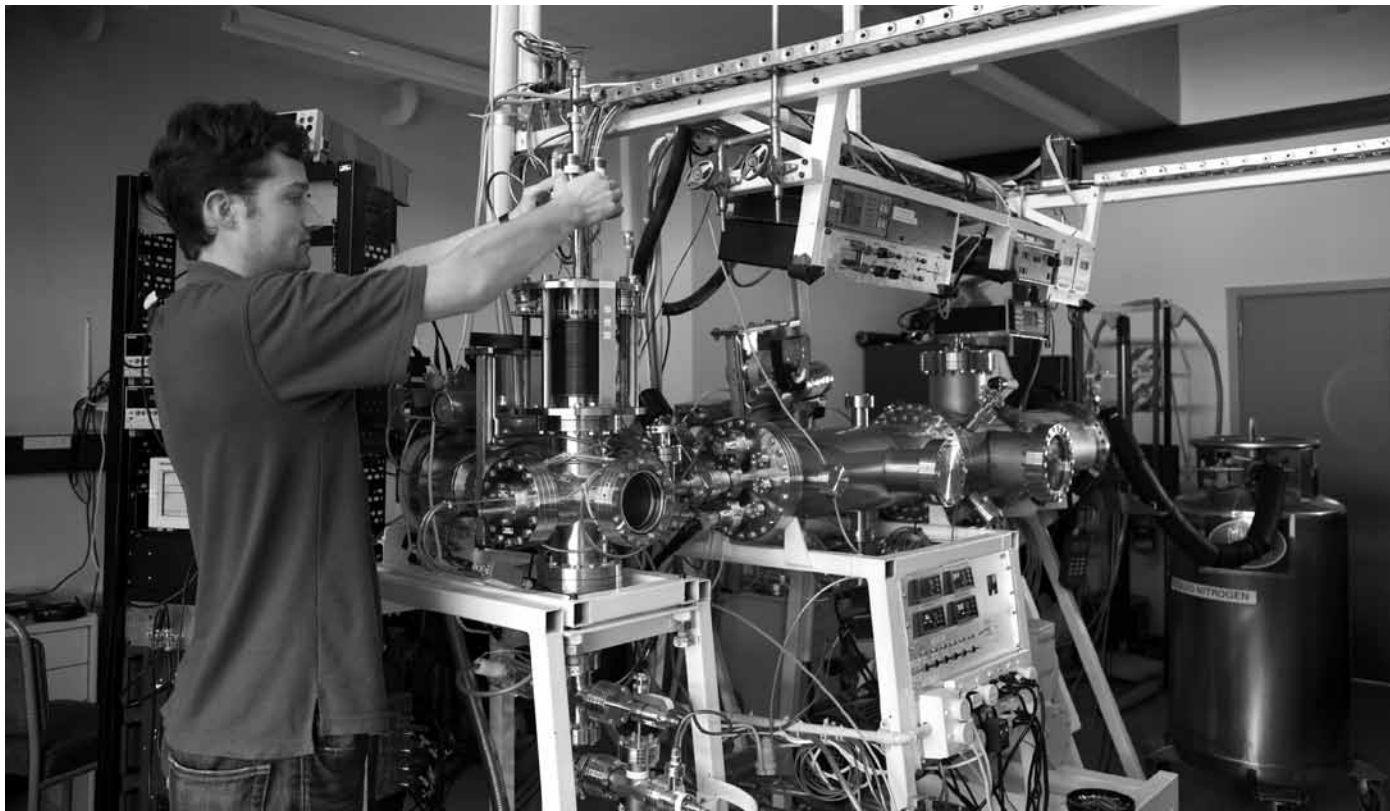
Theoretical Physics

(including mathematical physics, general relativity and cosmology)

Since the time of Galileo and Newton, theoretical physicists have been engaged in weaving a coherent understanding of the universe and its constituents, using mathematics, physical intuition and imagination to decipher what we observe. The successes of 300 years of technological development are witness to the fact that our theoretical descriptions are by now very mature, and exquisitely detailed; but the story is still far from complete.



Research, field stations and international collaborations (continued)



The theoretical physics group at the University of Canterbury is vibrantly engaged in pushing forward the current frontiers to solve mysteries that still abound: What is the Universe made of? Can we write down mathematically consistent laws of physics that describe all possible particles and their interactions? Can gravity be unified with the other forces of nature in a quantum theory?

Our specific interests revolve around understanding the large-scale structure of the universe, deciphering interactions of high energy neutrinos in antarctic ice in the RICE and ICE Cube experiments, unravelling the nature of particles produced terrestrially in high-energy colliders and cosmologically as mysterious dark-matter that outweighs the known stars and interstellar diffuse gas by a factor of three to five.

Our mathematical tools are Einstein's general relativity to describe gravity on one hand, and quantum field theories through which we understand matter on the other. Sometimes, these two realms collide and pose questions that take us to the limits of our understanding. At other times we contribute by walking through the subtle mathematical and conceptual terrain at the boundaries of these theories. In all this we inspire and educate our students and, in

some small way, contribute to the cumulative knowledge base of humanity, and also add that poetic touch to life that makes it just a wee bit deeper and grander.

Ring Laser Physics

With applications in geophysics

The Ring Laser Group at the University of Canterbury (together with our collaborator in Germany – Prof Ulrich Schreiber of the Technical University of Munich) operates the world's largest and most sensitive ring laser gyroscopes, in a dedicated and unique facility, the Cashmere Cavern Laboratory 30 metres underneath the Port Hills in Christchurch.

Our largest laser, ultra G-2 encloses an area of 833m². The laser gyros measure rotation, with extraordinary precision and easily detect the Earth's rotation as a steady background signal. We see disturbances in this steady background due to geophysical events such as earthquakes, and the gravitational influences of the sun and moon, which cause the earth to wobble on its axis. New areas of interest include the development of all solid state active laser interferometers and magneto-birefringence studies of chiral liquids.

Medical Physics

The Medical Physics Research Group covers a range of projects from radiation therapy, imaging, optical techniques and laser applications in medicine and surgery.

Much of the research is targeted at understanding, predicting and measuring the radiation dose received by patients in both treatment and imaging. Additionally, there is a strong core of research using MRI to understand brain function, connectivity, and the effects of brain injury and degenerative diseases such as Parkinson's disease. Optical techniques using fluorescence are investigated to identify pathogens or to detect tumours.

Collaborations with Veritide in NZ, Pokoa in the United States and the Biophysical Research Centre in Hungary are also involved in this work. A group collaborating with the MediPix project from CERN in Genève Switzerland is designing 3D spectroscopic x-ray scanner to give the first true full colour x-ray images. Strong collaborations exist with local medical researchers and clinicians, most of the New Zealand Cancer Centres, and the National Radiation Laboratory. Researchers also have collaborations with the University of Wuerzburg, Germany, Cornell University Medical School and Vanderbilt University Medical Centre in the US.

Academic Staff

Dr Jenni Adams

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Room 618
Phone: 364 2987 ext 6581



Jenni's research interests are in cosmology and astroparticle physics. Astroparticle physics involves topics at the interface of astronomy and particle physics where input is needed from both areas to tackle the research questions. Her group is involved in IceCube, a neutrino telescope installed deep in the ice below the South Pole which will help us to understand issues surrounding the highest energy processes in the Universe today. Some of the questions we are looking at are the processes driving gamma ray bursts, the origin of the most energetic cosmic rays and the identity of dark matter.

Dr Dharamvir Ahluwalia

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Room 716
Phone: 364 2987 ext 6563



I was born in the winter of 1952 in a small Indian village called Fatehpur in North India. The simplicity of a pre-industrial life, when nights of India were still lighted by the moon and the milkyway, deeply affected my academic and personal evolution. The seduction of the light bulb now collides with the quiet night light of Indian sky, and this collision inspires my science and my life.

After my undergraduate education at University of Delhi as a National Science Talent Scholar, I obtained an MA in Film-making and Physics from the State University of New York at Buffalo. In the Fall of 1991, I obtained a PhD from Texas A&M University. The years 1992-1998 were spent at the Los Alamos National Laboratory (LANL); first, as Director's Postdoctoral Fellow and later as a consultant and staff member. During the six years at LANL, besides many other things, I came to appreciate experimental side of physics, and it had enormous influence on my thinking as a theoretical physicist.

From the Fall of 1998 till May 2006 I was at University of Zacatecas (UAZ), Mexico. In Mexico I found that certain idealism and support for scholarship still thrives in the crevices of desert mountains. I made friends, and did research, in the quietness of La Bufa.

Since June 2006, I have made Department of Physics and Astronomy of the University of Canterbury as my academic home. Here, one can find a ring laser in the backyard of a cosmologist, and at the same time look at beautiful clouds, be soaked in rain and blue sky, and be enveloped by trees and birds, clean sea and rivers. But it lacks the sound of thunder, which I miss.

My scientific landscape spans work on neutrino oscillations, to the studies at the interface of the gravitational and quantum realms, to the representation space theory in a quantum field theoretic context.

Presently, I am focusing my efforts on a new quantum field theoretic construct that explains the darkness of dark matter and carries important implications for astrophysics and cosmology. I am also working on quantum entanglement and neutrino oscillations.

The larger story I wish to weave is the story of metamorphosis of light into being.

Dr Michael Albrow

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Room 814
Phone: 364 2987 ext 8163



Michael's main interests are in searching for extrasolar planets via microlensing and transits, studying globular clusters and their constituent stars, and studying the surfaces of stars. He is the project scientist for the Southern African Large Telescope (SALT) high resolution spectrograph and is our representative on the SALT Science Working Group.

Prof Jack Baggaley

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Jack's programme is devoted to the dynamics of dust grains in interplanetary space and the Galaxy solar neighbourhood. Radar systems have been developed to provide mapping of the sources of such grains and also the orbits of Earth-impacting meteoroids with several international collaborations (UK, USA) and support from the European Space Operations Centre. In atmospheric projects meteoric plasma is employed to probe the dynamical structure and aeronomy of the Earth's atmosphere.

Prof Simon Brown

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Room 608
Phone: 364 2987 ext 6567



Simon's main research interest is in the properties of nanometre scale particles (called 'atomic clusters') and in developing ways of building nano-electronic devices from these clusters.

His group are currently working on cluster-based devices with applications ranging from chemical sensors to magnetic field sensors to transistors, as well as more fundamental issues related to the devices, such as superconductivity and the origin of unusual memristor-like behaviour. The group also has a new ultra high vacuum scanning tunneling / atomic force microscope which is used to study the atomic structure and electronic properties of metallic and molecular nanostructures.

Prof Phil Butler

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Phone: 364 2987 ext 6541



Phil Butler is a mathematical physicist. His initial research interests were inspired as a PhD student by Brian Wybourne. His thesis was on computational methods, using the mathematics of symmetries and groups, in atomic and molecular spectroscopy. His interests now include a wide range of areas of pure and applied physics. He has developed the copper vapour laser treatment of port-wine stains (hemangiomas), modelled radio-therapy treatments for cancers, looked at correlations between brain function and personality, but keeps returning to the conceptual issues and the mathematics at the foundation of physics. He remains involved in the public understanding of science. He was a founding trustee of both Science Alive!, the New Zealand Science Centre, and the Science Technology Roadshow Trust, and has supervised several thesis students in science education. Currently Phil leads the MARS-CT research project. MARS-CT is an x-ray imaging scanner that uses the energy sensitive, photon counting Medipix chip. Each chip has 64k pixels and brings full colour x-ray imaging to the biomedical imaging scene. Phil shares his time with employment in the department and employment in the spin-out company MARS Biomaging Ltd.

Academic Staff (continued)

Assoc Prof Peter Cottrell

Dean of Science

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Peter's research activities are divided between the acquisition and analysis of observational data of stars and the development of new instruments for large telescopes. In analysing stellar observations he works with graduate students in determining the composition of stars as well as the dynamical changes that occur in stars on varying timescales - from minutes to tens of days. In instrumental developments, Peter led a team designing a large spectrograph for the Southern African Large Telescope (SALT: www.salt.ac.za). The University of Canterbury is a partner in the SALT project, an 11m optical telescope which began operating at an excellent site in South Africa in 2005.

Dr Ravi Danthakani

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Room 720
Ext. 7513



Ravi was born in India and moved to Canterbury in 2008 and later becoming a formalised NZ citizen. He enjoys the experience of supervising the delivery of the electronic courses. Ravi comes from an electronic background, both educational and industrial. He loves to explore the happenings in semiconductor devices and other wise micro electronics, medical physics/electronics and instrumentation.

Prof John Hearnshaw

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Phone: 364 2987 ext 6533



John was born in Wellington and grew up in the UK where he studied Natural Sciences at Cambridge. After graduating in 1967 he did his PhD in astronomy at the Australian National University (1968-72, studying element abundances in old stars) and then he had postdoctoral fellowships in France at the Paris Observatory (1972-74) and at Harvard University and the Smithsonian Astrophysical Observatory in the US (1974-76). Finally he returned to NZ in 1976 as a lecturer in astronomy at UC.

Over the last three decades at UC he has worked on stellar spectra, element abundances, stellar radial velocities, variable stars, binary stars and gravitational microlensing. In this time he has helped develop instruments and telescopes at Mt John University Observatory, especially for stellar spectroscopy at high resolution. He has been director of Mt John for a number of years.

John has written three books for Cambridge University Press on various aspects of the history and development of astrophysics over the last 150 years. In the last 10 years he has worked actively for the International Astronomical Union and currently chairs an IAU committee for the world-wide development of astronomy (work that takes him to developing countries to report on the state of astronomy in remote corners of the world).

Apart from the countries already mentioned he has also worked for extended periods in Germany, Italy, Japan, South Africa, Scotland, Sweden, Canada and Spain. At the present time he has research collaborations with astronomers in Venezuela, USA, Japan, Australia and Spain, work that involves respectively the spectra of supergiant stars, the gaseous interstellar medium near the sun, gravitational microlensing and the search for extrasolar planets, and optical afterglows from gamma-ray bursters.

Dr Adrian McDonald

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Phone: 364 2987 ext 6281



Adrian's main research interests are related to atmospheric remote sensing. Current studies using the groups' radar systems focus on the use of long-term observations from the Scott Base MF radar to examine the reliability of General Circulation Models and the use of high-resolution ST radar measurements in the development of a greater understanding of atmospheric convection. Other projects focus on understanding the distribution of atmospheric constituents (eg, ozone, aerosols, etc.) with respect to the large scale dynamics of the atmosphere.

Dr Juergen Meyer

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Room 820
Phone: 364 2987 ext 7588



Juergen studied Medical Engineering in Germany and Medical Instrumentation in the UK. After brief spell in industry he did his PhD in Intensity Modulated Radiotherapy in the UK. This was followed by a position as Senior Fellow at the University of Washington Medical Centre, USA, where he was part of an industry sponsored international research consortium on intensity modulated radiation therapy.

Before moving to New Zealand Juergen worked at the University Hospital in Wuerzburg Germany as a clinical Medical Physicist in the radiotherapy department. Besides clinical work with cancer patients, Juergen was strongly involved in research investigating the possibility of real-time correction of respiratory induced tumour movement using a robotic couch. At Wuerzburg he was also part of an international consortium on image-guided radiation therapy.

His general research interest are intensity-modulated radiotherapy, image-guided radiotherapy and stereotactic radiotherapy. He has a particular interest in both real-time tracking and adaptation of lung tumours.

Dr Karen Pollard

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Room 812
Phone: 364 2987 ext 7545



Karen did her BSc(Hons) in Physics and PhD in Astronomy at the University of Canterbury. She then went to Cape Town, South Africa where she worked as a postdoctoral fellow at the South African Astronomical Observatory (SAAO).

In 1995, while working at the SAAO, she was a founding member of the PLANET collaboration (Probing Lensing Anomalies NETWORK), undertaking observations to search for planets via the microlensing technique using the 1.0m telescope at the Sutherland Observatory in South Africa.

She returned to New Zealand as a FORST postdoctoral fellow, studying the properties and pulsations of evolved low-mass supergiant stars. Following this she moved to the east coast of the United States where she took up an assistant lectureship position at the Physics Department of Gettysburg College. Karen returned to New Zealand in 2001 when she took up a lecturer position at the University of Canterbury. Her research interests are searching for extrasolar planets via the microlensing technique, studying the radial and non-radial pulsations of unstable stars using time-series photometric and spectroscopic observations.

Prof Roger Reeves

Head of Department

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Roger was born and raised in Canterbury and attended the University of Canterbury where he graduated with BSc(Hons) and PhD degrees.

Roger is currently serving as Head of the

Department of Physics and Astronomy. Roger's research interest lies in laser spectroscopy of thin films. Recently he and his group have been concentrating on the group-III nitrides, particularly the InN bandgap controversy, and through a productive collaboration with the Ioffe Institute, he has a programme on the properties of fluoride superlattices.

Assoc Prof Michael Reid

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Phone: 364 2548



Mike's research is largely directed towards understanding the optical properties of materials containing lanthanide ("rare earth") ions. Lanthanide materials are widely used in lamp and

display phosphors, and other optical devices such as lasers and amplifiers. Current projects seek to understand the excited state electronic structure and dynamics by using a range of experimental and computational modelling techniques.

Other interests include the application of symmetry principles (group theory) in spectroscopy.

Dr Jon-Paul Wells

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Room 618
Phone: 364 2987 ext 7517



Jon finished his PhD in laser spectroscopy of rare earth doped optoelectronic materials in 1997. He spent March 1997 - Feb 1999 at the University of Strathclyde in Glasgow (UK) where femtosecond pump-probe

techniques were performed with the broad objective of understanding non-radiative processes in near infrared emitters.

In March 1999 he moved to the Dutch FELIX free electron laser facility in Nieuwegein. In close collaboration with Universiteit Utrecht and the University of Canterbury, an extensive vibrational dynamics programme was developed.

From June 2002 until June 2006, he held a lectureship in ultrafast semiconductor physics in the Department of Physics and Astronomy at the University of Sheffield, working on some rather diverse problems in the physics of optoelectronic materials. In August 2006, he returned to New Zealand to lead the ring laser group at Canterbury.

Assoc Prof Dr David Wiltshire

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Phone: 364 2987 ext 6473



David works in general relativity and cosmology. He did his PhD at the University of Cambridge in the mid 1980s, in the group led by Stephen Hawking.

This was followed by research and teaching positions at the ICTP, Trieste, Italy, the University of Newcastle-Upon-Tyne, UK, and the University of Adelaide, South Australia. He returned to the Department in 2001 after 18 years overseas.

David has expertise in the theoretical and mathematical aspects of the physics of black holes, the origin and structure of the universe, and models of gravity which attempt to unify the forces of nature by incorporating extra spatial dimensions. He has done pioneering work on higher-dimensional black holes and "brane worlds". His current work is focussed on the problem of averaging the geometry that arises from the inhomogeneous distribution of clusters of galaxies and voids as structure formation proceeds. This may be a route to understanding the apparent acceleration of the expansion of the universe at late epochs, commonly attributed to "dark energy".

Entry requirements and contacts

Entry to a BSc degree is open to all students with University Entrance. Most science subjects can be started at first-year university level without previous study.

However, a background to NCEA Level 3 in physics and mathematics with calculus is recommended for some physics courses. If you haven't got this background, you may need to take a preparatory course. Please contact the Head of Department or Liaison officer for more information.

Preparatory Courses

Headstart Physics

A Headstart preparatory course in physics (equivalent to NCEA level 2) is held each summer prior to the start of the first semester.

This course provides valuable preparation for students wishing to advance in Physics, Engineering or other science-based courses that require a basic knowledge of physics.

The course consists of lectures, tutorials, problem classes and an introduction to the laboratory. You will be expected to do some set work in your own time.

If you are enrolling in Headstart Physics, you should consider enrolling in Headstart Mathematics too.

Certificate in University Preparation

The University offers a Certificate in University Preparation (CUP), designed for New Zealand citizens or permanent residents from English speaking backgrounds, who do not meet the requirements for university entrance through their existing qualifications. The CUP welcomes students who have recently finished Year 13 programmes, but who missed university entrance, are under 20 and left school without formal qualifications, or who have been out of school for many years and want to refresh their study skills, before beginning a degree programme.

To find out more about the Certificate of University Preparation or Headstart Physics, or to obtain a brochure and application form, ring the University of Canterbury Contact Centre on Freephone 0800 VARSITY (827 748) or email: certuniprep@canterbury.ac.nz



Emily Brunsten

Bachelor of Science with Honours in Astronomy and Postgraduate Diploma in Teaching (Secondary)

Currently studying towards a PhD in Astronomy, Emily is passionate about Science and Science Education, sharing current research with everyone from school age to the general public. Now her research on pulsating stars takes her from using telescopes at Mt John University Observatory and in Australia and China to collaborating with colleagues in Belgium and Australia as part of a leading astronomical research group.

Subject information

For full degree requirements, course restrictions, prerequisites, point allocations and regulations please refer to the University Calendar. For times and locations of specific lectures, laboratories and examinations, please refer to the Enrolment Handbook or the Department's website at www.phys.canterbury.ac.nz

Contacts

The Department webpage is a great way to access information: www.phys.canterbury.ac.nz

Please contact us if you have any questions regarding our courses or research.

Head of Department

Professor Roger Reeves
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General enquiries

Phone: +64 3 364 2404
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Level and subject coordinators

100-level Coordinator

Professor Simon Brown
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200-level Coordinator

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400-level Coordinator

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Astronomy

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Phone: +64 03 364 2987 ext 7545

Medical Physics

Dr Juergen Meyer
Email: juergen.meyer@canterbury.ac.nz
Phone: +64 03 364 2987 Ext: 7588

Student Advisor, College of Science

The Student Advisor is available to provide academic advice and assistance on courses options and/or degree programmes in science subjects:

Tracey Robinson

Phone: +64 3 364 2987 ext 3132
Email: tracey.robinson@canterbury.ac.nz

UC Contact Centre

For more information about study options or an enrolment pack get in touch with the Contact Centre:
Freephone: 0800 VARSITY (0800 827 748 in NZ)
Or phone: +64 3 364 2555
Email: enrol@canterbury.ac.nz
Web: www.canterbury.ac.nz

FAQs

Do I need Year 13 physics to begin first year physics?

The normal entry requirement for PHYS 101 is a 'good pass' in both secondary school physics and mathematics with calculus, ie, 14 credits in Level 3 NCEA physics and 14 credits in level 3 NCEA mathematics with calculus.

Students who do not qualify for admission to PHYS 101 in the Semester 1, but who do have university entrance, may take PHYS 111 in the Semester 1 and PHYS 101 in the Semester 2. They can then take PHYS 102 in the summer semester. Further details are given elsewhere in this handbook.

Passes in alternative secondary school level qualifications, such as Cambridge AS, International Baccalaureate, and University Foundation courses will usually be acceptable alternatives to NCEA.

What courses are available to broaden my general knowledge?

The Semester 1 course ASTR 112 (Astrophysics) and the Semester 2 course PHYS 109 (The Cosmos: Birth and Evolution) are both popular with students from diverse backgrounds who have an interest in a broad education.

The Department also contributes to the interdisciplinary course ANTA 101 (Antarctic Studies). The theme of our contribution is the interaction of the sun's radiation and the solar wind with the atmosphere. The course outline can be viewed online for a full list of topics covered.

Can I change courses that I chose when pre-enrolling?

Yes, you can change your courses up until the second week of the semester with absolutely no penalties. You will need to see an undergraduate supervisor to make changes.

Do I need to buy textbooks for all my Physics and Astronomy courses?

Most Physics and Astronomy courses require textbooks, while some rely on course handouts and photocopies. Where required you will benefit from buying a textbook as it will get good use!

What does the academic writing assessment test involve?

To enter Year 2 Physics courses or First Professional Engineering you are required to demonstrate that you can write clear, coherent English in a style appropriate to university level courses and technical reports. As part of the coursework for ENGR 101 an academic writing test will be given in Semester 1.

Students planning to major in Physics or Astronomy will sit this test as well. Physics and Astronomy students enrolled in Semester 2 courses will be tested separately. There will be lectures to help you prepare for this test.

Is there flexibility with labs and tutorials?

Yes there is flexibility. Where there are large classes such as PHYS 111, 101 or 102 you are advised to attend the tutorial or laboratory time given to you. However, if this time is not suitable please attend the first available tutorial or laboratory listed in the course outline in order to finalise the stream you will attend for the duration of the course.

How does the Department support students with disabilities?

Special arrangements can be made for students with any kind of disability to complete courses offered in the Physics and Astronomy Department. If you have special needs, please discuss these with the Head of Department and your course lecturers, or email the Disability Resource Service disabilities@canterbury.ac.nz

Who should I discuss problems or learning difficulties with?

Lecturers are always more than happy to discuss any problems or difficulties you may have with their course. You can arrange an appointment by seeing them after class or by phoning or emailing them. If you have problems that you do not feel comfortable talking to your lecturer about, you can also go to the Head of Department, the 100-level co-ordinator or your tutor.

Course tutors are available during specific office hours to deal with any course related questions you may have.

Student support

Information and Communication Technology Services

Information and Communication Technology Services (ICTS) provides students with access to the University's computer facilities. There are computer workrooms (Mac and PC) on campus which operate 24 hours a day, seven days a week and all students receive information about how to access these during the enrolment process. All workrooms are connected to the internet. The Helpdesk and the Campus Computers shop are on the ground floor of the ICTS Building.

ICT Service Desk

Phone: +64 3 364 2060
Email: ictservicedesk@canterbury.ac.nz

Campus Computers

Phone: +64 3 364 2341
Email: campuscomputers@canterbury.ac.nz

Health Services

Student health services are available from the University Health Centre, which is situated beside the Students' Association building.

Phone: +64 3 364 2402
Website: www.canterbury.ac.nz/healthcentre

Library

Library staff are pleased to help you with any queries. They look forward to helping you make the most of their resources and services.

Phone: +64 3 364 2987 ext 8723
Website: www.library.canterbury.ac.nz

Childcare

Childcare is available at the University of Canterbury's Students' Association Childcare Centre. For further information:

Phone: +64 3 348 4336
Email: childcare@ucsa.canterbury.ac.nz

Recreation Centre

The Recreation Centre offers a full range of fitness, sporting and recreation activities. Qualified staff are ready to help you with all your fitness and recreation needs. For further information contact:

Phone: +64 3 364 2433
Website: www.phed.canterbury.ac.nz

Plan your degree

Create your own personalised BSc degree

3								
2								
1								

Create your own personalised BSc(Hons) degree

4								
3								
2								
1								

University of Canterbury

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